COMPARATIVE EVALUATION OF FRESH FRUIT JUICES SOLD BY STREET VENDORS VERSUS RESTAURANTS

By

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THESIS
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DECLARATION

I hereby declare that this thesis entitled **"Comparative evaluation of fresh fruit juices sold by street vendors versus restaurants"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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Certified that this thesis, entitled **"Comparative evaluation of fresh fruit juices sold by street vendors versus restaurants"** is a research work done independently by **Miss. T. Bindhya Dhanesh**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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ABBREVIATIONS

BHC	-	Benzene Hexa Chloride
cfu	-	colony forming unit
DDT	-	Dichloro Diphenyl Trichloroethane
E.coli	-	*Escherichia coli*
FAO	-	Food and Agricultural Organisation
g	-	gram
HACCP	-	Hazard Analysis and Critical Control Point
HIV	-	Human Immunodeficiency Virus
kg	-	Kilogram
LDL	-	Low Density Lipoprotein
mg	-	milligram
ml	-	milliliter
ppm	-	parts per million
ROS	-	Reactive Oxygen Species
RTE	-	Ready To Eat
WHO	-	World Health Organisation

INTRODUCTION

1. INTRODUCTION

As in many parts of the world, the cities of East and South-east Asia are in the grip of sudden and unprecedented urban growth with a consequent rise in their labour forces. As population pressure on a main city increases, large settlements are often established near the suburbs. Thus, long and medium distance commuting has become a way of urban life and people are becoming increasingly busy with their day to day activities which allow them very little time to prepare food at home. Hence, the effect of urbanization has shown an increase in the amount of food eaten outside the home. As a result, commercially prepared meals and other ready-to-eat foods and beverages are being increasingly consumed from street vending stalls and restaurants.

Street foods have been defined as "ready-to-eat foods and beverages prepared and/or sold by vendors especially in streets and similar public places"(FAO,1989).

The preparation and sale of street foods is an age-old activity. These foods are available for a fraction of cost of a restaurant meal. In this era of rapid urbanization and industrialization, an informal sector for sale of food has thus developed as a typically indigenous response for catering to the needs of the people in most of the cities of the developing world. It not only serves as a cheap source of food for the urban poor but also provides a significant source of income to many people.

Street food vending is a common practice in most parts of the world, and provides breakfast, lunch, dinner, snacks and refreshment items to a large cross-section of consumers. Street foods have found wide acceptance by the general population because they are available at low cost, have acceptable taste and are conveniently sold wherever crowds of people congregate like schools, market places, railway station, office centers etc. As a result, the cheap eating houses which were in abundance even years ago are increasing in numbers by the vendors who sold only raw commodities in past, now selling prepared foods of a wide variety. Small shops have been replaced by transportable kiosks in many cases.

In spite of the tremendous economic activity generated by the street foods and their role in meeting the food, socio-economic and cultural needs of the community,

the street food sector has still not been recognized like the restaurants in many countries and continues to be treated as a marginal activity, and even a public nuisance in some countries. This perhaps is due to the fact that several governments, local bodies or city officials have a negative attitude towards street food vendors who are often seen as an undesirable aspect of urbanization which should disappear in due course as a result of development.

Out of the different fast foods sold in the fast food service centers, fruit based beverages like fresh fruit juices, shakes and other ready-to-serve beverages are the items which has come up with the utmost preference. Fruit juices and fruit beverages are becoming popular due to their pleasing flavour, taste and nutritional characteristics. Moreover, they are a source of refreshment too.

Fruit juice consumption in many parts of the world has increased in recent years due to the public perception of juices as a healthy natural source of nutrients and increased public interest in health issues. Fresh fruit and fruit juice consumption has a lot of health benefits. Juices from fruits are pure and vital liquids of great healing power. They are not only a source of refreshment but also a source of powerful antioxidants (Browne, 2007). The vitamin rich fruit juices strengthen the body and prevent the degeneration of skin, flesh, glands and organs. When considering juice, the freshness of juice is vitally important. Fresh fruit juices should be squeezed and consumed as soon as possible because it quickly loses its nutritional value after being squeezed.

However, in the recent years, the increasing consumer awareness about the preparation of foods and beverages in different food service centers has emphasized the need for microbiologically safe food because fast foods can be the cause of several types of food borne diseases. Microbial contamination of food and beverages is an indicator of poor sanitary practices in the preparation and storage of food. Pathogenic microorganisms can enter the food through raw materials, unclean cooking materials, water used for different preparations, environmental contamination and personal hygiene of the workers.

The detection of pathogenic microorganisms in foods help in controlling food borne infections; the estimation of level of microbial contamination in food allows assessing the quality of food which is important from the health and economic point of view (WHO, 1989). The consumers have several expectations on the ready-to-eat foods available in different outlets including the nutritive value, freshness and safety. So, it is imperative to focus sufficient attention on quality assurance and hygienic standards of foods. Hence, the present study has been undertaken to evaluate the quality attributes and microbial safety of selected fresh fruit juices sold in the street vending stalls and restaurants of Thrissur Corporation.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The concept of health has prevailed from centuries and dietary habits are apparently changing with modernisation. "Healthy eating" is now perceived to be important. The desirability of a healthy life style has led to an increased consumption of fruit juices. (Banan and Hegde, 2005).

Consumption pattern of beverages are changing and a consumer demands variety, shelf life and proper preservation techniques to preserve beverages. If proper safety precautions are not adhered, beverages might become a source of food borne diseases. Serious health problems arise due to the consumption of foods contaminated with pathogens or microbially spoiled foods. In this study, survey of literature by pertinent texts and research related to the study was carried out and is presented under the following headings.

2.1. Nutritional and health benefits of fresh fruit juices.
2.2. Consumption pattern of street foods and beverages.
2.3.Contaminants in street foods and beverages
- 2.3.1. Contamination with synthetic colours
- 2.3.2. Microbial contamination
- 2.3.3. Contamination with heavy metals, pests, pesticides and preservatives

2.1.Nutritional and health benefits of fresh fruit juices

Fruit juices prepared from natural fruits and clarified juices are considerably altered in composition before it is served as a drink (Lal *et al*., 1998).

Shivappurkar *et al.* (1988) and Yu *et al.* (2005) indicated the antioxidative and antiproliferative activity of ellagic acid present in fruits and fruit juices and reported its effect to bind certain carcinogens, including nitrosamines and polycyclic aromatic hydrocarbons. Vattem and Shetty (2005) indicated the chemoprotective effect of ellagic acid and its action to reduce oxidative stress.

Block (1991) reported significant protection against cancer of oesophagus, larynx, oral cavity and pancreas due to the presence of vitamin C and β carotene in fresh fruits and fruit juices. The antioxidant effect of fruit and fruit juices due to the presence of phenolic flavonoids, carotenoids and glucosinolates was reported by Kaur and Kapoor (2001). Arendt *et al*. (2001) observed an increased Trolox Equivalent Antioxidant Capacity in fruit juice supplemented HIV patients due to the presence of polyphenols in fruits.

A significant increase in β carotene, vitamin C, vitamin E, selenium and folate levels of blood and thus the antioxidant capacity were observed in healthy male and female subjects after a supplementation with mixed fresh fruit and vegetable juices (Kiefer *et al*., 2004). Burr *et al*. (2007) observed an increase in serum β carotene, a potent antioxidant in pregnant women who consumed fruit juices regularly.

Consumption of fruits and vegetables either raw or juice was found to be effective in preventing or alleviating diseases like atherosclerosis, diabetes, cancer, arthritis and also ageing and thus to promote good health (Kaur and Kapoor, 2001). The effect of fresh fruit juices rich in anthocyanins in reducing oxidative DNA damage and increased glutathione status was observed by Weisel *et al.* (2006).

Wilson and Temple (2004) reported the detoxification, immunostimulating, antiviral, anticancer and antioxidant properties of fruit and fruit juices due to the presence of biologically active phytochemicals

Lee *et al*. (2003) reported the antibacterial activity of fresh fruit juice extracts against *Staphylococcus epidermidis, Klebsiella pneumonia* and other pathogens. Daily consumption of fresh fruits and fruit juices was also found to be effective in healing the lesions caused by *Helicobacter pylori* in the mucous lining of stomach and to provide protection against stomach cancer due to the presence of antioxidant vitamin (Keto *et al*. 2004).

Animal studies conducted by Mathur *et al*. (1996) indicated lowered serum lipid levels and anti atherosclerotic effect of fruit juices especially *Emblica officinalis*.

The effect of fruit juices mainly apple and black current rich in flavonoids in increasing plasma ascorbic acid and glutathione peroxidase activity and reducing plasma malondialdehyde level and thus reducing the risk of cardio vascular diseases was reported by Young *et al.* (1999). Similarly, in a study conducted by Banan and Hegde (2005) to find the acidogenic potential of commonly consumed fruit juices namely grape, orange and pineapple on plaque and saliva pH changes, it was observed that grape juice had more acidogenic potential than orange and pineapple juices and caused a great drop in plaque formation and salivary pH changes.

Cook *et al*. (1997) found that consumption of fresh fruit and juice improved the lung function in subjects suffering from wheezing due to the presence of vitamin C. Similarly, the association between frequent consumption of fresh fruit juices with higher lung function was indicated by Carey *et al*. (1998) in subjects suffering from chronic respiratory diseases. Willers *et al*. (2007) also reported that consumption of apple and other fruit juices during pregnancy offered protective effect against the development of childhood asthma and allergic diseases.

A study on the antioxidant activity of dietary phenolic compounds, ubiquitous in vegetables, fruits and their juices was conducted by Persona *et al.* (1999) in apples and observed that apple juice inhibited LDL oxidation in human subjects. Protective effect of apple juice attributed by the phytochemicals like carotenoids, flavonoids, isoflavonoids and phenolic acid was indicated by Boyer and Lui (2004). The authors also indicated the inhibitory effect of apple juice in cancer cell proliferation, regulatory, inflammatory and immune response and providing protection against lipid oxidation.

The anti-inflammatory and antioxidant activity of *Aronic melanocarpa* juice rich in anthocyanin was reported by Kuzmanova *et al*. (2004). Similarly, Valcheva *et al.* (2007) indicated that the phenolic substances and anthocyanins in *Aronic melanocarpa* fruit juice were effective in reducing hyper-lipidemia and thus the risk of cardio vascular diseases.

The effectiveness of fresh cranberry juice in maintaining urinary tract health by acidifying urine through a mechanism of anti adhesion against certain urinary

pathogens was reported by Leahy *et al*. (2001). Kontiokari *et al.* (2003) also indicated decreased risk of recurrence of urinary tract infections by the frequent consumption of fresh cranberry juice.

Utsunomiyaa *et al*. (2002) reported the potent antioxidant activity of oriental plum and indicated that the fruit juice of oriental plum helped to improve human blood fluidity by inhibiting angiotensin II- induced epidermal growth factor receptor trans activation.

High antioxidant efficiency due to the presence of phenols in fresh orange juice was reported by Rapisarda *et al.,* (1999). The authors also indicated that daily consumption of orange juice could provide additional protection against *in vivo* oxidation of cellular biomolecules. Concepcion *et al*., (2003) found an increase in plasma vitamin C concentration in healthy subjects after daily supplementation of 500ml fresh orange juice. Consumption of orange beverages led to an 11 per cent reduction in levels of c-reactive protein produced in liver, a known marker of inflammation and a good predictor for the onset of type II diabetes and cardio vascular diseases and three per cent reduction in fibrinogen in subjects suffering from peripheral arterial disease (Dalgard *et al.*, 2009).

Consumption of citrus fruits and their juice was found to be effective in decreasing alkaline phosphate and acid phosphate activity and restoring femoral density and thus femoral strength (Deyhein *et al*., 2005). Health benefits of phytochemicals like flavonoids, limonoids, ferrocoumarins and pectins of citrus fruits and juices was indicated by Patil *et al,* (2006). Browne (2007) analysed citrus fruit juices for nutrients and found citrus fruit juices as good source of vitamin C.

Nutritive value of fresh fruit juices namely avocado juice, orange juice, apple juice, banana juice and guava juice was evaluated by Jedah and Robinson (2002) and observed high amount of energy and potassium in avocado juice followed by banana juice. The authors also indicated guava juice as an outstanding source of vitamin C and carotene.

The antioxidant property of guava juice due to the presence of vitamin C and carotene was reported by Jedah and Robinson (2002).

The effectiveness of gooseberry juice as a well-known dietary iron enhancer due to the presence of vitamin C was indicated by Gopaldas (2002). The author also indicated the effectiveness of gooseberry juice in reducing iron deficiency anaemia among young working women.

Kotecha *et al*. (1994) reported that the banana juice from overripe fruits had more TSS, reducing sugar, less acidity and tannin than that from normal ripe fruits.

Natarajan (1979) and Nambiar *et al*. (1990) indicated that cashew apple juice is a rich source of β carotene and Vitamin C and contains more than five times as much vitamin C than that of citrus fruits. Authors also reported the presence of free aminoacids like proline, arginine and lysine in cashew apple juice.

Vijayakumar (1991) indicated the benefits of cashew apple juice as a remedy for cough and cold and for the treatment of syphilis. The medicinal properties of cashew apple and cashew apple juice were enumerated by Nair (1995) as a cure for scurvy, diarrohea, uterine complaints, neurological pain, rheumatism and cholera.

The presence of Anacardiac acid and (E)-2-hexenal in cashew apple juice exhibited antibacterial activity against gram negative bacteria like *Helicobacter pylori* which is considered to cause acute gastritis (Kubo *et al*., 1999). The authors also reported the effect of these antibacterial compounds in inhibiting urease production and its activity.

The physico-chemical properties of few tropical fruits such as pineapple, orange, grape, mango and lemon were analysed by Akinwale (2000) and compared with those of cashew apple, and found that cashew apple juice had the highest amount of vitamin C than other fruits.

Bicalho (2001) reported the presence of volatile compounds like esters, terpenes, hydrocarbons, carboxylic acids, aldehydes, alcohols, ketones, lactones and isoprenoid in cashew apple juice.

The unique ability of noni juice in curing hypo and hypertension was indicated by Sahelian (2001). The author also reported the anticancer and immune system strengthening potential of noni juice.

Aviram *et al.* (2002) reported the effectiveness of flavonoids in pomegranate juice in inhibiting LDL oxidation and atherosclerosis. The authors also demonstrated the antioxidant and antiatherogenic effect of pomegranate polyphenols. The ability of pomegranate juice in reducing blood pressure and thickness of carotid artery wall due to the presence of ellagic acid was studied by Aviram *et al*. (2004). Seeram *et al*. (2005) also indicated the anti proliferative and antioxidant properties of ellagic acid present in pomegranate juice.

Bub *et al.* (2003) reported the antioxidative, immunomodulatory and antigenotoxic effects of polyphenol rich fruit juices namely grape and pomegranate juice.

Keevil *et al*. (2000) reported the platelet inhibitory activity of purple grape juice in reducing the risk of coronary thrombosis and myocardial infarction. Strong antioxidant and pharmacological properties of grape juice polyphenols were reported by Bagehi and Bagehi (2000) with potentials for chemoprevention of various cancers. The protective effect of flavonoids in Concord grape juice against oxidative stress and thus reducing the risk of free radical damage and cancer and other chronic diseases was indicated by Bryne *et al*. (2002).

Reduction in the ROS/photon content by 15 per cent in adults by consuming grape juice was indicated by Parke *et al*. (2003). The authors indicated the capacity of grape juice in scavenging ROS and thus defending cellular DNA from oxidative damage and in turn protection from cancer. Cancer protective effects of polyphenols in grape juices due to free radical scavenging modifying enzymes that activate or

detoxify carcinogens and modulating enzyme activities were indicated by Lambert and Hong (2005).

Jo *et al*. (2006) reported that the grape juice rich in procyanidin significantly reduced viability of liver cancer cells without any cytotoxicity to non-cancerous kidney cells. Similarly, Katiyar (2007) reported that procyanidin rich grape juice prevented skin cancer by boosting the immune system.

Free radical scavenging activity, inhibition of lipid peroxidation and xenobiotic metabolising enzymes as well as anti tumor promoting activity of crude polyphenols in Indian grape juice was reported by Ramachandani *et al.* (2008). The presence of phenolic antioxidants in grape juice from simple catechins and epicatechins to complex tannins was indicated by Ramachandani and Chettiyar (2009).

Gao and Budhraja (2009) observed that resveratrol, a phytonutrient abundant in grape juice interfered with cancer cell growth and induce cell death or apoptosis. The authors also observed its ability to inhibit cell proliferation that stimulates the cancer cell growth as well as increasing the immune response.

Browne (2007) analysed carrot juice and found that it is a good source of vitamin A in the form of β carotene. Rajesh (2009) indicated carrot juice as a miracle juice due to the presence of β carotene and vitamin E and minerals like calcium, copper, magnesium, potassium, sodium, phosphorous, chlorine, sulphur and iron. The author also indicated the effectiveness of carrot juice in preventing dryness of skin and eyes and in maintaining healthy digestive system, urinary tract and its ability to fight against bacterial infections.

2.2.Consumption pattern of street foods and beverages

Street foods have become an integral part of the urban lifestyle especially for the working population and children (Cohen, 1986). Winarno and Allain (1991) also indicated that due to the easy availability and accessibility of street foods, it became an integral part in Asia, Latin America and Africa.

Life style changes and accompanying urbanization together with rising affluence appear to be largely responsible for increased consumption of fast foods (Howden *et al.* 1993). The authors observed that students rely heavily on street foods because of demand for convenience and low cost.

In Calcutta, Chakravarty (1996) interviewed 911 consumers who consumed street foods and about 80 per cent of consumers were found to be men in the age group of 19-48 years. The author also indicated that 33 per cent purchased street foods on daily basis, while 23 per cent patronized stalls 1-4 times per week. In a study conducted by Kaynak *et al*. (1996) it was indicated that school children and most working male population heavily depended on fast foods from various street outlets due to their taste, low cost and easy accessibility.

Binkley and Bales (1998), Bhatt and Waghray (2000) and Peter (2004) indicated low cost as an important determinant for the increased demand for street foods. Similarly, Davis and Browne (1999) found that hunger and food cravings, appeal of food, time consideration, convenience, food availability, cost and media as the factors influencing food choices among adults which in turn led to increased consumption of fast foods.

Vijayapushpam *et al.* (2003) indicated significant increase in the consumption pattern of fast foods from streets by low socio-economic status population because of low cost and easy availability from these outlets.

Kowsalya and Shyny (2005) in a study conducted in Malappuram indicated that 90 per cent of the respondents preferred fruit juices from streets and restaurants due to their taste and 22 per cent preferred due to their nutritive value. Akanle and Olutayo (2009) also indicated taste and low price as the reasons for increased consumption of fast foods among consumers. Must *et al.* (2009) indicated easy availability and accessibility, low cost and increased taste as the reasons for the consumption of fast foods.

From the social and economic point of view street foods are of greater help to workers who cannot obtain foods at affordable prices (Poulos and Bhat, 2000). The authors observed irregular jobs and poverty as the reasons for the increased consumption of street foods in India.

Bhatt and Waghray (2000) observed that most of the customers buying tiffin from street outlets were males belonging to middle income group followed by school children and college students. Chandrasekhar *et al*. (2003) also indicated that male members had more access to street foods than females.

Forsher and Storey (2003) indicated increased consumption of citrus fruit juices and milk based beverages among children and adolescents from street outlets. The authors also indicated that boys drank more beverages from street outlets than girls and older teenagers drank more fruit juices than milk based beverages.

Adair and Popkin (2005) observed increased consumption of fast foods among children in the age group of 5 to 19 years. Niemeir *et al*. (2005) observed increased consumption of fast foods among adolescents and adults of working class who do not have time to prepare meals. Kowsalya and Shyny (2005) observed increased consumption of fruit juices from streets and restaurants among school children, adolescents and adults of both working and non-working classes.

Akanle and Olutayo (2009) observed increased consumption of fast foods among children and teenagers. Similarly, Diltrich (2009) found that due to economic growth and new life style, demand for various fast foods has been increased followed by increased consumption by all age groups of population.

Globalisation had increased the trend in consumption of fast foods from the street outlets of developed countries (Adair and Popkin, 2005). Must *et al*. (2009) observed that eating patterns of fast food by younger age groups increased to a greater rate from sites like service food outlets, submarine sandwich shops, ice cream shops and street vendors.

2.3. Contaminants in street foods and beverages

2.3.1. Contamination with synthetic colours

Chakravarty and Canet (1995) detected non-permitted colours like metanil yellow in sherbet, jalebi, laddu and fresh fruit juices available in the street outlets of Calcutta. Dixit *et al*. (1995) also observed non-permitted colours and non food grade dyes in eatables sold in the rural markets of Uttar Pradesh. Stoots *et al.* (1999) reported the presence of non-food grade additives like textile colouring agents in the foods sold in the street vending stalls of West Java, Indonesia. The authors also indicated the presence of banned coal tar colour in soft drinks.

Presence of banned food colours like metanil yellow, orange II in popular sweets like jalebi and *bundi laddu* and rhodamine B, auramine orange G in sugar candy, cotton candy, flow candy and coconut burfi sold by the street vendors of Bangladesh was reported by Rajprem *et al.* (2000).

Heber and Bowerman (2001) indicated the presence of different non-permitted food colours in many food samples from the street outlets in India. Similarly, in 72 different samples of sweet meat and confectioneries collected from large and small shops of Rawalpindi street of Uttar Pradesh, Ashfaq and Maseed (2002) observed 18 to 220ppm of permitted as well as non-permitted colours. Kim *et al*. (2002) also observed the presence of banned colours in 36 per cent of soft drink samples prepared and sold by the local street vendors of Vietnam.

Presence of non-permitted colours in amounts exceeding the statutory limits in majority of the foods sold at kiosks in both urban and rural areas was reported by Rao and Bhat (2003). Rao *et al*. (2004) also observed high amount of food colours in most of the ready-to-eat foods available at the street outlets. The authors indicated that 90 per cent of the foods sold through the street outlets had permitted colours which crossed the standard limits, 8 per cent of foods had non-permitted food colours mainly rhodamine and observed 18757 ppm of non-permitted colours in sweet meat, 9450ppm in fruit juices and 3811ppm in sugar confectioneries.

Ohiokpehai (2003) observed high amounts of azodyes in margarine and fruit juices sold in various outlets in Botswana. Similarly, tartrazine and sunset yellow were observed in sweets, sweet meat and fruit beverages sold in the stalls of Hyderabad in amounts exceeding the required limits (Rao *et al.,* 2005). Sethy (2005) observed colouring agents above the permitted levels in commercially available fruit juices.

Presence of non-permitted colours in various street foods in Pune city was reported by Obisaw, (2007). Similarly, Nayak and Nath (2007) found high levels of non-permitted colours in foods like gobi manjurian, kababs, fish fry and fruit beverages.

Dixit *et al.* (2008) found excessive amounts artificial colours like carmoisine, erythrosine, sunset yellow**,** tartrazine and ponceau 4R in tomato and chilli sauces at street food joints of Lucknow. Rao and Sudersan (2008) also observed the presence of high amounts of tartrazine and sunset yellow in sweet meat and fruit juices from street outlets of Hyderabad. The authors indicated the presence of high amounts of carmoisine, ponceau 4R and erythrosine in fruit beverages.

Sawaya *et al*. (2008) indicated the presence of food colours exceeding statutory levels in 334 ready-to-eat food items in Kuwait.

2.3.2. Microbial contamination

Microbiological evaluation of sugarcane juice sold by street vendors of Pune city was conducted by Shetty *et al.* (1981) and indicated the presence of high total viable count, *Staphylococcus*, *faecal coliforms* and *Vibrio cholera.* Kumari (1995) also observed high load of total viable organisms, yeast and moulds, *Staphylococcus aureus* and *Coliforms* in sugarcane juice.

Chakravarty and Canet (1995) observed the presence of *Salmonella* and *Shigella* in food and beverage samples collected from different street outlets of Calcutta. The authors also indicated the presence of *E.coli* in seven out of 52 juice samples and *Salmonella* in the ice used in beverages.

Singh *et al. (*1995) indicated the presence of *E.coli*, *Vibrio cholrea, Salmonella spp., Vibrio parahaemolyticus, Bacillus cereus* and *Shigella* in orange juice, *faecal coliforms* and low counts of *Salomella* in sugarcane and lime juice collected from various street outlets of Faridpur. Microbial evaluation of pineapple and lemon juices by Sharma (1995) indicated that fresh lemon juice had zero total viable count, where as, fresh pineapple juice had $0.15x10^2$ to $0.21x10^2$ total viable count.

Meerarami *et al.* (1997) indicated aflatoxin production due to the presence of *Aspergillus spp.,* in 52 samples of milk collected from outlets around Chennai city.

Kakar *et al.* (1998) evaluated 56 fried food samples like samosa, bhatawada and patra collected from streets and indicated the presence of high counts of *Staphylococcus* and *Salmonella* in majority of the samples.

Microbiological quality of tamarind, mango and green chutney sold in small shops and streets of Mumbai city was analysed by Kakar and Udipi (2000) and indicated the presence of *Staphylococcus*, total *faecal coliforms*, total *faecal streptococcus* and *Clostridium spp.* in all samples of chutneys. The authors also indicated the presence of *Shigella* in one sample of green chutney, *Streptococcus enteridis* in two samples of green and tamarind each and *Streptococcus newport* in one sample of tamarind chutney.

One hundred and twenty samples of raw vegetables, fruits and sprouts sold by street vendors to prepare foods were analysed by Viswanathan and Kaur (2001) and indicated the presence of pathogens like *Staphylococcus aureus, E.coli, Enterobacter spp., Klebsiella, Salmonella typhii* and *Serratia* in almost all the samples.

Microbiological analysis of street vended freshly squeezed carrot and Kinnow-Mandarian juice in Patiala city of India was conducted by Sandeep *et al.* (2001) and indicated the presence of high total viable counts, *faecal coliforms*, *Streptococcus* and *Salmonella* in carrot juice.

Kakar and Udipi (2002) analysed food samples collected from railway stalls, small shops and streets of Mumbai city and indicated the presence of high total viable count, Staphylococcal count, *faecal coliform* count and faecal streptococcal count in all meat food samples. The authors detected *Staphylococcus aureus* in chicken rolls and mutton chops and *Salmonella* species mainly *Salmonella gallinarum* and *Salmonella typhinurium* in chicken and mutton burger and pizza.

Microbiological evaluation of different street foods in Bhubaneswar was conducted by Mohapatra *et al*. (2002) and indicated the presence of *faecal coliforms* in all the samples. The authors also indicated the presence of *Bacillus species, Staphylococcus*, *Shigella* and *E.coli* in all the samples of panipuri, chat, dahibara and ice creams. Microbiological quality of milk, vegetables and fruit juices was conducted by Khan and Malik (2002) and indicated the presence of *Staphylococci* and *faecal coliforms* in all samples.

Mukhopadyaya *et al*. (2002) conducted microbiological evaluation of 35 ripe papaya slices sold by the roadside vendors in Calcutta and indicated the presence of *Coliforms*, *faecal coliforms*, *Staphylococcus aureus* and *Vibrio cholera* in all the samples. Sripathy *et al.* (2002) examined mango, orange and pineapple juices from different outlets for microbial quality and observed a total bacterial and staphylococcal count of less than 50 cfu per ml and 10 cfu per ml respectively in fruit juices. The authors also observed high *Coliform* and staphylococcal count in sugarcane juice. However, tender coconut juice was free from *Coliforms*.

Singh and Sankhla (2003) analysed sixty-four samples of sugarcane juice collected from different categories of vendors and shopkeepers and the samples obtained from the vendors were found to be highly contaminated with microbes. HACCP analysis of food samples sold by street vendors in Kochi was conducted by Chandrasekhar *et al.* (2003) and indicated high microbial counts in bengal gram curry and detected *Staphylococcus spp., Bacillus spp.* and *faecal coliforms* in the food samples.

Quality evaluation of bottled drinking water (Ambili *et al.,* 2003) of different brands available in and around Thrissur district indicated the presence of *Coliforms*, *Staphylococci, faecal staphylococci* and *Pseudomonas* in most of the samples. Spores of *Clostridium spp*. at hazardous levels were observed in drinking water and other food stuffs by Vasanthi and Natarajan (2003).

Quality evaluation of pasteurized milk (John *et al.,* 2003) and toned pasteurized milk (Sethulakshmi *et al*., 2003) of different brands available in and around Thrissur district indicated the presence of *Coliforms*, *Staphylococci*, *faecal Streptococci* and *Pseudomonas* in most of the samples. Vasanthi and Natarajan (2003) indicated spores of *Clostridium spp*. at hazardous level in raw and pasteurized milk, cream, ghee and cheese.

Eight samples of panipuri each consisting of individual items of pani, puri and masala collected from the street vending sites of Mysore city was analysed for the microbiological quality by Sathishbabu and Rati (2003) and indicated high level of contamination with mesophilic aerobes, C*oliforms* and *Yersinia spp.* in foods. Baskar *et al.* (2004) conducted microbiological analysis of street foods in Mangalore city and indicated the presence of high total viable counts, *Salmonella spp*. and *E. coli* in almost all the samples.

Sheth *et al*. (2005a) analysed bhelpuri samples sold by the street vendors of Vadodara for the microbiological quality and indicated the presence of *Staphylococcus aureus* in all the samples and detected *E.coli, Salmonella* and *Shigella* in 60 per cent of samples. Sheth *et al*. (2005b) indicated the presence of high total mesophilic aerobic bacteria*, Staphylococcus aureus, E.coli, Salmonella* and *Shigella* in 80 per cent of dish water samples and 60 per cent of food items like sandwiches, cooked vegetables, fruit juices, sherbets and chutneys sold by the street vendors of Vadodara.

Kowsalya and Shyny (2005) conducted microbiological evaluation of various beverages sold by street vendors and in restaurants of Malappuram district, Kerala and indicated high bacterial count in grape juice, orange juice and sapota shake collected from restaurants. *Klebsiella* and *E.coli* were also detected in some beverages

collected from restaurants while juices prepared with sugarcane, *nannari*, pineapple, watermelon, lime and orange by street vendors were found to be grossly polluted with pathogens like *Salmonella* and *E.coli*. *Klebsiella* was also detected in sugarcane juice, sherbet and nannari juice. Fungal contamination was also observed in all the samples.

Rao *et al.* (2006) evaluated different street vended fruit juices of Vishakapatnam city for the microbiological quality. The authors analysed orange, grape, mango, pomegranate, apple, pineapple, watermelon, papaya and carrot juices and indicated the presence of *faecal coliforms* and *faecal Streptococcus* in all the fruit juices. The authors also detected *Salmonella* and *Shigella* in many fruit juice samples. Rajanna *et al*. (2006) also indicated the presence of abnormally high bacterial loads, *faecal* S*treptococci*, *E.coli* and *Salmonella typhii* in street vended freshly squeezed fruit juices.

Chumber *et al*. (2007) indicated the presence of bacterial pathogens like *E.coli, Salmonella* and *Shigella* in various street vended food samples of Pune city. Tambekar *et al.* (2009) analysed 52 samples of street vended fruit juices namely sweet lemon juice, pineapple, pomegranate, apple and orange juice in Amaravati city and indicated the presence of *E.coli, Pseudomonas, Salmonella spp., Klebsiella spp. and Enterobacter spp.* in the juice.

Bryan *et al.* (1988) indicated high mean aerobic plate count (5 log cfu per g) in cooked beans from street vending sites of Dominican Republic. Bryan *et al*. (1992) also reported high mean aerobic plate count (more than 6 log cfu per g) in cooked chick pea and meat food items sold in the streets of Pakistan.

Dawson and Cannet (1991) indicated the presence of high total viable count, *Staphylococcus* and *faecal coliforms* in the foods sold by the street vendors of Senegal and reported more than 200 cases of food poisoning.

Microbiological evaluation of pineapple juice collected from restaurants of Malaysia indicted the presence of thermo tolerant coliforms such as *Escherichia coli, Klebsiella pneumoniae, Enterobactor agglomerans* and *Serratia rubidae* (Tchango *et al*.1992). Total bacterial count of freshly prepared carrot, *sobia*, tamarind and

sugarcane juice sold by street vendors of Egypt was studied by Daw *et al*. (1994) and detected coliforms in 90, 30 and 10 per cent of carrot, sugarcane and sobia samples respectively.

Arumugaswamy *et al*. (1995) indicated the presence of *Salmonella spp* namely *Salmonella blockley, Salmonella enteritidis, Salmonella chinicol, Salmonella muenchen* and *Salmonella agona* in various ready-to –eat foods like chicken, liver and gizzard sold in various outlets of Malaysia.

Koo *et al*. (1996) indicated the presence of *Vibrio cholera* in fruit juices and flavoured ice available at the street outlets of Gautemala**.**

Sobel *et al.* (1998) reported the presence of total and *faecal coliforms* and *E.coli* in stored water and different foods and beverages collected from street vending sites of Gautemala. Umoh and Odoba (1999) observed the presence of *Staphylococcus aureus*, *Bacillus cereus* and *Salmonella* in ready-to-eat foods and beverages purchased from street food sellers in Zaire, Nigeria.

Street food samples comprising of a variety of meat foods, salads and gravy were evaluated by Mosupya *et al*. (2000) and indicated the presence of *Bacillus cereus* in 17 per cent of food samples, *Clostridium perfringens* in one per cent and *Staphylococcus spp.*, *Enterobacteriaceae* and *Alcaligenes spp.* in almost all the samples.

Hussein *et al.* (2001) analysed water and street food samples from different street vending sites of Semarang, Indonesia and indicated contamination with *faecal coliforms* in all the samples.

Bacillus cereus and *Clostridium perfringens* were detected in salads and gravy collected from the street vending sites of South Africa (Kubheka *et al.,* 2001). Samosa, macroni, lentil sandwich, kitfo and egg sandwich collected from the street vending sites of Addis Abada were found to be contaminated with *Coliforms*, *Bacillus spp., Staphylococcus* and *Micrococcus* (Mulata and Ashenafi 2001). Presence of

Salmonella in cooked rice, beans, beef stew, chicken stew and roasted beef sold in the street outlets in Cameroon was reported by Akinji *et al*. (2002)

Fresh fruit juices sold through retail outlets in Qatar was evaluated by Jedah and Robinson (2002) and detected *Escherichia coli* and *Enterococcus faecalis* in mixed fruit juices and the microbiological contamination of the juices was found to be higher than the Gulf standards.

Falcao *et al.* (2002) indicated the presence of *E.coli, Salmonella spp., Shigella spp., Yersinia spp.*, *Vibrio cholerae and Aeromonas spp.*` in refrigerated ice, fish and ready-to-eat sea foods sold by the street vendors of the Araraquara city, Brazil

Presence of lactic acid bacteria, *Klebsiella pneumoniae, Enterobacter aerogenes, Enterobacter sakazakii* were detected in *Sobia*, a fermented drink of South Arabia sold by street vendors due to the use of contaminated water (Gassem 2002).

Igumbor *et al*. (2002) detected *Bacillus spp., Staphylococcus spp., Micrococcus spp., Streptococcus spp., Diphtheroids, Fusiform bacteria, Klebsiella spp. and Citrobater spp. i*n 58 samples of milk and ice creams collected from various outlets in Harare, Zimbabwe.

One hundred and sixty four samples of RTE food products sold in the streets of Taiwan were evaluated by Fang *et al*. (2003) and indicated highest incidence of *Coliforms, Bacillus cereus* and *Staphylococcus aureus* in sandwiches, noodles and rice balls and *E.coli* in almost all the food samples.

Thirty two samples of fruit juices collected from various restaurants and street outlets were examined by Boas *et al*. (2003) for the presence of moulds, yeast, coliform bacteria, *Escherichia coli* and *Salmonella spp.* and observed high mould and yeast counts in twenty one samples.

Azanza *et al.* (2004) analysed 'Day-old chick' and its sauce, a famous street food of Philippines and indicated the presence of *Staphylococcus* and *Salmonella* species.

Microbiological analysis of 27 samples of beef patties sold by the street vendors of Trinidad was conducted by Badria *et al*. (2004) and indicated the presence of *Salmonella, Staphylococcus aureus* and *E.coli* in all the samples. Njongmeta *et al*. (2004) analysed 300 RTE meat products sold by mobile food sellers and stationary food sellers of Cameroon and observed high *Staphylococcus* and *Salmonella* counts in samples collected from the mobile food sellers. The authors also detected yeast and mould in all the samples of Kilichi (sun-dried beef), *E.coli* in 30 per cent of the samples, *Bacillus* in 23 per cent, *Staphylococcus* in 19 per cent and *Salmonella spp*. in 15 per cent of the samples.

Ali *et al*. (2004) indicated faecal contamination in drinking water, dish water and ice samples collected from the street vendors of Indonesia and indicated the presence of *Salmonella typhii* also in drinking water and a few food samples. Food items sold by the street vendors in the Mexico city was analysed by Garcia *et al*. (2004) and indicated the presence of *Salmonella* and *E.coli* in the water samples used for the preparation of fruit beverages and other food items. The authors indicated high counts of *Salmonella spp.* in salad dressings sold by the vendors. Muinde and Kurian (2005) indicated the presence of harmful pathogens like *E.coli* and *Salmonella* in different street vended foods and beverages sold at the stalls of Nairobi, Kenya.

High total viable count, *Staphylococcus spp., Salmonella spp*. and *E.coli* in street foods from the restricted areas of Brazil were indicated by Hanashieo *et al*. (2005).

Barro *et al.* (2006) conducted microbiological evaluation of street foods, drinking water samples, dish washing water samples, utensils and money collected from the street vending sites of Africa and indicated the presence of *Coliforms, Staphylococcus aureus, Salmonella* and *Shigella* in all the food and water samples, *Coliforms* and *Staphylococcus spp*. in money and *Salmonella* and *Shigella* on the utensils.

Cowpea paste used to prepare *akara* collected from Nigerian market and streets was examined by Bulgarelli *et al*. (2006) and indicated contamination of the

paste with high counts of *Coliform bacteria*, *Klebsiella, Lactobacillus spp, Candida spp* and *Aspergillus niger* .

Ismail (2006) evaluated Hawawshy, a well known street food of Egypt and indicated the presence of a wide variety of microorganisms like total *Coliforms*, *Enterobacteriaceae*, *E.coli*, Coagulase positive *Staphylococcus*, *faecal Streptococcus, Citrobacter freundi*, *Klebsiella oxytoca, Klebsiella pneumoniae* and *Serratia liquefacians.*

The individual ingredients of hot dogs sold by the street vendors of Brazil were evaluated by Lucca and Torres (2006) and indicated the presence of pathogens namely *E.coli, Bacillus spp.*, and *Staphylococcus* in the meat, mashed potatoes and beef. The authors also detected *Salmonella* in the sauce used in the hot dog.

Oliveira *et al*. (2006) indicated the presence of *Staphylococcus spp, Salmonella spp.* and *E.coli* in fresh sugarcane juice sold by the street vendors of Brazil.

Gupta *et al.* (2007) indicated the presence *E.coli* in water samples used for cooking purposes by the vendors of Indonesia.

Staphylococcus aureus was isolated from 120 RTE foods like grilled meat, *moin-moin*, meat and fish sausages sold by the street vendors in Nigeria (Achi and Madubrike, 2007).

Seventy eight samples of different street vended foods of Malaysia were examined by Haryani *et al*. (2007) and indicated the presence of *Klebsiella pneumonia* along with *E.coli, Salmonella* and *Staphylococcu*s.

Selected street foods of Port Harcourt, Nigeria comprising of deep fat fried foods, baked foods, boiled and fermented foods were evaluated by Mepba *et al.* (2007) and observed highest heterotrophic counts in yoghurt and ice cream, *faecal coliforms* in pancakes, *moi moi*, cakes, meat pie and egg rolls, *Bacillus species, Klebsiella spp.*, *Staphylococcus spp*. and *Micrococcus* in many other food samples.

Mosupya *et al*. (2000) isolated different species of Bacillus namely *Bacillus cereus, Bacillus licheniformis* and *Bacillus subtilis* in many street food samples and indicated cytotoxic effects of these species on consumption of the contaminated foods.

Most popular Nigerian street food namely Sadza (maize flour porridge) was evaluated by Taulo *et al.* (2008) and indicated the presence of *E.coli, Staphylococcus aureus, Campylobacter jejuni* and *Salmonella* in all the samples collected. Microbiological quality of Sadza, stews (beef, chicken, and goat), boiled and fried vegetables, salads and water samples from the street vendors of Harare was evaluated by Gadagar *et al*. (2008) and indicated highest incidence of *Bacillus cereus* in 31 per cent of sadza, 21 per cent of stew, 14 per cent of salads and 7 per cent of vegetables. The authors also detected the presence of *E.coli, Salmonella* and *Staphylococcus* in the water samples.

High counts of *Vibrio cholerae* was detected in the water samples used for various preparations by the vendors of Zambia (Sasaki *et al.,* 2008). Nwachukwu *et al.* (2008) analysed sliced water melon and watermelon juice sold by the street vendors in Nigeria and indicated the presence of *E.coli, Klebsiella, Proteus mirabilis, Staphylococcus aureus, Lactobacillus spp*. and *Saccharomyces cerevisiae*. .

Improper handling of raw and cooked foods, improper cooking practices, poor sanitation, lack of education and low income of vendors were listed as the factors contributing for the contamination of street foods. Kakar *et al.* (1998), Hussein *et al*. (2001), Mulata and Ashenafi (2001), Chandrasekhar *et al.* (2003), Ali *et al*. (2004), Muinde and Kurian (2005), Barro *et al*. (2006), Oliveira *et al*. (2006), Rajanna *et al*.(2006) and Chumber *et al*. (2007).

Shetty *et al.* (1981) reported a cholera epidemic in Pune due to the consumption of contaminated sugarcane juice sold by the street vendors. Similarly, Koo *et al.* (1996) also reported epidemic cholera in Gautemala due to the consumption of contaminated street foods especially beverages. A cholera outbreak was reported by Hutin *et al*. (2003) in the Kano city hospital due to the consumption of beverages contaminated with *Vibrio cholerae.*

Singh *et al.* (1995) reported a diarrhoeal outbreak at Faridpur due to the consumption of contaminated orange juice

2.3.3. Contamination with heavy metals, pests, pesticides and preservatives

Pasha *et al.* (1994) indicated the presence of iron, zinc and copper in fruit juices and indicated that though they are within permissible limits it indicates contamination from pesticidal residue, water and machines used for juice extraction.

Venkataraman and Anandavalli (1995) reported that surface water samples used to prepare soft drinks in the five different stations of Tuticorin coast contained heavy metals. Tanaka *et al*. (1996) detected arsenic, lead, cadmium and antimony in soft drinks.

Forty five samples of musambi juice from different categories of sellers in Udaipur city was studied for the presence of trace minerals and minerals like iron (1.45mg), nickel (0.53mg), copper (0.27mg), manganese (0.16mg), cadmium (0.19mg) and lead (0.89mg) were found in all the samples (Choudhary, 1999).

Chromium levels of fruit juices was determined by Garcia *et al*. (1999) and upto 17.60 µg per litre was detected. The authors also indicated 3.6 to 60.50µg per litre of chromium in soft drinks.

Several beverages including fruit juices and food drinks available in the market of Nigeria was analysed for cadmium, cobalt, chromium, iron, nickel, lead and zinc by Onianwa *et al*. (1999) and indicated the presence of metals within statutory limits.

Levels of manganese (15-22 ppm) in commercial pineapple juice purchased in Australia and UK were found to be much higher than other fruit juices (Beattie and Quoc, 2000). The authors also indicated the presence of small amounts of chromium, iron, nickel and copper in fruit juices.

Joshi (2000) observed the presence of high levels of lead in sweets sold by the street vendors near the bus parks of Khatmandu. From the street vending stalls of Indonesia, Liu *et al.* (2000) indicated the presence of heavy metals like lead and iron in hot dog, *bakmi* (noodle soup with meat balls) and *nasi aduk* (steamed rice with coconut milk and spices) and the source of contamination was found to be through automobile exhaust fumes.

Hutabarat (2001) revealed the presence of lead in meals (3.04ppm), beverages (1.05ppm) and snacks (0.27-4.32ppm) sold by the street vendors in Thailand. Fresh fruit juices were analysed for aluminium concentration by Sepe *et al.* (2001) and indicated higher levels of aluminium in apricot juice followed by pear and peach juices.

High levels of copper was observed in various street foods like aloo bajji, onion bajji, masala dosa and dahi vada collected from the street vending sites of Pune city (Shetty *et al.,* 2003).

The content of lead, cadmium, copper and zinc in fresh fruit and juices available in polish market were evaluated by Krijpio *et al.* (2005) and indicated the presence of lead, cadmium, copper and zinc in 9.6 per cent of fruit samples and lead and cadmium in 88 per cent of fruit juices. Sethy (2005) indicated heavy metal contamination in commercially available fruit beverages.

Maduabuchi *et al*. (2007) indicated the presence of arsenic and chromium in 55.2 per cent of fresh fruit juices and 33.3 per cent of canned juices sold in small stalls of Nigeria.

In view of the increase food borne illnesses associated with the consumption of fresh fruits and fresh fruit juices, Sela *et al.* (2005) investigated and found Mediterranean fruit fly as a potential vector for the transmission of human pathogens like *E.coli* in fruits.

The occurrence of pesticide residue in green vegetables and other food products sold by the street vendors in Khatmandu was reported by Joshi (2000).

Similarly, Chandra *et al*. (2001) indicated pesticide residues in fresh fruits and vegetables collected from the street vending stalls of Sri Lanka. Presence of pesticide tetradefon was found in two samples of orange juice sold by the street vendors of Japan (Vatanasuchet, 2001).

Pesticide residues in fruit juices were detected by Tadeo and Sanchez (2003) and recoveries obtained from the pesticides in different juices were found to be higher than 74 per cent and the detection limits ranged from 1-5 µg per kg.

Dialkyl phosphates in fresh fruit juices as a result of organophosphorus pesticide degradation especially in orange and apple juice was indicated by Lu *et al*. (2005).

Different authors have reported organochlorine residues, DDT, BHC, lead, cadmium, mercury, nickel, arsenic etc in beverages like human and dairy milk, milk products and yoghurt (Naseema *et al*., 1991; Visalakshi *et al*., 1991; Hande, 1992; Sanchez *et al*., 1996; Szkoda and Zmudzki, 1996; Sanchez *et al*., 1997; Surendranath *et al*., 2000 and NIN, 2002).

In Sri Lanka, formalin was detected as a substitute for ice in preserving fish sold by the street food vendors (Thaneiy, 2000). Sodium benzoate in excess of permitted levels was indicated in beverage samples collected from the street vendors of Thailand (Hutabarat, 2001). Out of the 74 food samples collected from the street vending sites of Bangkok, ten beverages and two snacks were identified with high levels of benzoic acid (Vatanasuchet, 2001)

Lianghui *et al.* (2003) reported that street food vendors in China misused chemical preservatives like sodium nitrite in foods which are highly carcinogenic. Presence of an illegal preservative namely boric acid in various street vended foods of Malaysia was identified by Perdigon (2005). The author indicated that the vendors used boric acid to bleach and to give a shine to food products like rice noodles.

Mould inhibitors like sodium benzoate and sodium meta bisulphite in street foods sold by the street vendors of Japan was reported by Chin (2005). The author

also indicated the presence of texture modifiers like 'bleng', a borate containing salt in noodles, tapioca and chips.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The materials and methods adopted for the study entitled "Comparative evaluation of fresh fruit juices sold by street vendors versus restaurants" are given under the following headings.

3.1. Selection of the area for the study

3.2. Selection of the consumers and vendors

3.3. Plan of study

3.4. Methods adopted for the study

3.5. Statistical analysis

3.1. Selection of the area for the study

Among the fifty two divisions in Thrissur Corporation, five divisions namely III, XV, XVIII, XXXVI and XXXXI were selected randomly for the study. From each of the selected five wards, seven street vending sites and three restaurants were selected randomly. Thus, a total of thirty five street vending sites and fifteen restaurants were selected for the study. From the selected thirty five street vending sites and fifteen restaurants, six street vending sites and four restaurants were selected randomly to collect the fresh fruit juices for the study.

3.2. Selection of the consumers and vendors

From each of the thirty five street vending sites and fifteen restaurants, two adult consumers were selected randomly to study the consumption pattern of fruit juices. Thus, seventy consumers coming to the street vending sites and thirty consumers coming to the restaurants were selected to study the consumption pattern of fruit juices.

At each of the selected sites, the vendors and restaurant workers who prepare the fruit juices were interviewed to collect the general information of vendors and restaurants workers. Thus, a total of thirty five street vendors and fifteen restaurant workers were selected.

3.3. Plan of study

Based on the objectives of the study the plan of study was designed. The study comprised of

3.3.1. A survey to collect general information of vendors and restaurant workers and their knowledge and practices

3.3.2. A survey to collect details on the consumption pattern of fruit juices by the consumers

3.3.3. Selection and collection of fruit juices

3.3.4. Quality evaluation of selected fresh fruit juices

3.3.4.1. Evaluation of chemical constituents in fresh fruit juices

3.3.4.2. Enumeration of microorganisms in fresh fruit juices

3.3.5. Statistical analysis and interpretation of data

3.4. Methods adopted for the study

3.4.1. General information of vendors and restaurant workers and their knowledge and practices

Interview method was used to collect the general information of the vendors and restaurant workers and their knowledge and practices. For this purpose a semi-structured interview schedule was prepared. The schedule comprised of the general information pertaining to the vendors like age, sex, total monthly income, experience of running the stall and duration of running the stall daily. Knowledge and practices

of the vendors and the workers with respect to personal hygiene, environmental sanitation, food safety, preparation, cleaning practices, availability of water and serving practices were also collected from the vendors. The semi-structured schedule used to collect the information is given in Appendix I. The details pertaining to the general cleanliness of vendors and workers, preparation area, surroundings of the stall and personal hygiene of the vendors and workers were also collected by on-the-spot observation.

3.4.2. Consumption pattern of fruit juices by the consumers

Details on the frequency of consumption, type and quantity of fruit juices consumed, reasons for consumption, frequency of visit to the same vendor and experience in consuming fruit juices by the consumers were collected by interview method. A semi-structured interview schedule was prepared for this purpose and the details were collected from the selected consumers. The interview schedule to collect the information from the consumers is given in Appendix II.

3.4.3. Selection and collection of fresh fruit juices

On the basis of the availability and frequency of consumption of fruit juices by the consumers three fresh fruit juices namely pineapple juice, grape juice and lime juice were selected for quality evaluation. The fruit juices were collected from the selected six street vending sites and four restaurants during summer season. Each fruit juice was collected in triplicate samples. Thus, eighteen samples of each fruit juice from the selected six street vending sites and twelve samples of each fruit juice from the selected four restaurants were collected for the study. Altogether fifty four fruit juice samples from street vending sites and thirty six fruit juice samples from restaurants were collected for the study.

All the fruit juice samples intended for the analysis of chemical constituents were collected in sterilized bottles and kept in ice boxes. The samples were then transported immediately to the laboratory and analysed within six hours of collection. For the microbial analysis, the samples were collected in autoclaved graduated test

tubes half filled with buffer. These samples were also brought in ice boxes and analysed within six hours of collection.

3.4.4. Quality evaluation of selected fresh fruit juices

3.4.4.1. Evaluation of chemical constituents of fresh fruit juices

The fresh fruit juices were evaluated for the following chemical constituents using standard procedures.

1. Acidity
2. pH
3. Total Soluble Solids(TSS)
4. Reducing sugar
5. Total sugar
6. Non-reducing sugar
7. Vitamin C
8. β carotene
9. Sodium
10. Potassium
11. Food colours(qualitative)

1. Acidity

Titratable acidity of samples was estimated by the method suggested by Ranganna (1986). Ten ml of the fresh fruit juice was made up to 100ml. Ten ml of this was then titrated against 0.1 N NaOH using phenolphthalein as indicator. Acidity was expressed in terms of citric acid per 100ml of fruit juice

2. pH

pH of the fruit juices was determined using a pH meter.

3. TSS

Total Soluble Solids in fruit juices were recorded using a hand refractometer (Erma, Japan) of brix ranging from 0-32°brix at room temperature and values were expressed in degree brix (Ranganna, 1986).

4. Reducing sugar

The content of reducing sugar in samples was estimated by the method suggested by Lane and Eyon (Ranganna, 1986). To 25ml fruit juice, 100ml distilled water was added and then clarified with neutral lead acetate. The excess lead acetate was removed by adding potassium oxalate. The volume was then made up to 250ml. Twenty five ml of this solution was then titrated against a mixture of 10ml Fehling's A and B using methylene blue indicator. The reducing sugar was expressed in percentage.

5. Total sugar

Total sugar was determined using the method given by Lane and Eyon (Ranganna, 1986). From the clarified solution used for the estimation of reducing sugar, 50ml was taken and boiled gently after adding citric acid and water. It was later neutralized with NaOH and the volume was made up to 250ml. Twenty five ml of this solution was then titrated against a mixture of 5 ml of Fehling's A and B each. The total sugar was expressed in percentage.

6. Non-reducing sugar

Non-reducing sugar was determined by subtracting the reducing sugar content from the total sugar content. Non-reducing sugar was also expressed in percentage.

7. Vitamin C

The vitamin C content of fruit juices was estimated by the method suggested by Sadasivam and Manickam (1992). A volume of 5ml of fresh fruit juice was mixed with 4 per cent oxalic acid, made up to 100 ml and the supernatant was titrated. Ten ml of the supernatant was titrated against the dye solution 2, 6-dichlorophenol indophenol until the appearance of a pink colour which persisted at least for 15 seconds. It was then expressed in mg per 100ml of fruit juice.

8. β carotene

β carotene content was estimated by the method of AOAC (1980) using saturated n-butanol. To 5ml of fruit juice, 50ml of saturated n-butanol was added and shaken for one minute and kept overnight. The supernatant was decanted and the colour intensity was noted at 435.8nm in a spectrophotometer. The β carotene content was expressed in µg per 100ml of fruit juice.

9. Sodium

The sodium content of fruit juice was estimated using flame photometer as suggested by Jackson (1973). One ml of juice sample was digested in diacid and made up to 100ml with distilled water. From this made up solution, one ml was directly fed to flame photometer and the reading was taken and expressed the sodium content in mg per 100ml of juice.

10. Potassium

The potassium content of fruit juice was estimated using the same procedure used for the estimation of sodium suggested by Jackson (1973) and the content was expressed in mg per 100ml of the juice.

11. Food colours (qualitative)

(a) Metanil yellow

One ml of fruit juice sample was taken in a test tube and to this was added few drops of concentrated HCl and the change in colour was noted as suggested by Srilakshmi (2003).

(b) Others

10ml of water was added to 5ml of juice and change in colour was noted as suggested by Srilakshmi (2003).

3.4.4.2. Enumeration of microorganisms in fruit juices

Enumeration of total micro flora of fresh fruit juices was done by serial dilution and plate count method as described by Agarwal and Hasija (1986). One ml of the sample was transferred to a test tube containing 9ml peptone water to get 10^{-2} dilution. Similarly, 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} dilutions were also prepared serially.

Enumeration of total micro flora was carried out using Nutrient Agar medium for bacteria, Potato Dextrose Agar for mould and Saboraud Dextrose Agar for yeast and EMB Agar for *E.coli* obtained from Himedia laboratory, Mumbai.

For the enumeration of *Salmonella*, selective enrichment was done using selenite cysteine broth suggested by Harrigan (1998). One ml of the fruit juice was added to 10 ml of selenite cysteine broth and mixed thoroughly. The broth was then incubated at 42°C for 18 to 24 hours. Serial dilution in peptone water was done using one ml of the broth and then pour plated on Salmonella-Shigella agar obtained from Himedia laboratory, Mumbai.

Confirmation test for *Salmonella* was also carried out as suggested by Barrow and Feltham (1993).

3.5. Statistical Analysis

The observations recorded were tabulated and the data was analysed statistically using Kruskal-Wallis one way analysis of variance by ranks and T-test wherever required.

RESULT

4. RESULT

The result pertaining to the study entitled "Comparative evaluation of fresh fruit juices sold by street vendors versus restaurants" are presented under the following headings.

1. General information of the street vendors and restaurant workers
2. Practices adopted by the street vendors and restaurant workers
3. Consumption pattern of fruit juices by the consumers
4. Quality evaluation of fresh fruit juices
   4.1. Chemical constituents of fresh fruit juices
   4.2. Enumeration of microorganisms in fresh fruit juices

4.1. General information of the street vendors and restaurant workers

Details on the general information of the vendors are given in Table 1. It was seen that 71.43 per cent of the street vendors and 40 per cent of the restaurant workers were below 20 years of age and 22.86 per cent of the street vendors and 26.67 per cent of restaurant workers belonged to the age group of 20-30 years. Rest of the street vendors (5.71%) and restaurant workers (33.33%) were within the age of 30 to 40 years.

Majority of the street vendors (85.71%) earned a monthly income of less than Rs.1000 and the rest (14.29%) earned an income in the range of Rs.1000-3000 rupees per month. Nearly 66.67 per cent of the restaurant workers earned an income in between Rs.1000-3000 per month and the rest of the restaurant workers (33.33%) earned more than Rs.3000 per month.

All the street vendors were found to be engaged in other jobs like tailoring, foot wear repairing and also worked as vegetable hawkers. Majority of the street vendors (85.71%) earned up to Rs.1000 from such jobs and 14.29 per cent earned an income in between Rs.1000-2000 per month. Only 53.33 per cent of the restaurant workers were found to be engaged in other jobs like selling

vegetables and worked in video shops and earned an income in the range Rs.1000-2000 per month.

Table1 - General Information of the street vendors and restaurant workers

Sl.no	Details	Street vendors N= 35	Restaurant workers N= 15
1	**Age**		
	< 20 years	25 (71.43)	6 (40)
	20-30 years	8 (22.86)	4 (26.67)
	30-40 years	2 (5.71)	5 (33.33)
2	**Monthly income**		
	< Rs 1000	30 (85.71)	-
	Rs. 1000-3000	5 (14.29)	10 (66.67)
	> Rs. 3000	-	5 (33.33)
3	**Income from other jobs**		
	No income	-	7 (46.67)
	< Rs. 1000	30 (85.71)	-
	Rs. 1000-2000	5 (14.29)	8 (53.33)
	> Rs. 2000	-	-
4	**Educational qualification**		
	Primary school	33 (94.29)	2 (13.33)
	High school	2 (5.71)	13 (86.67)
5	**License from Corporation**		
	Have obtained license	20 (57.14)	15 (100)
	No license	15 (42.86)	-
6	**Experience in work**		
	< 2 years	3 (8.57)	2 (13.33)
	2-5 years	4 (11.43)	13 (86.67)
	> 5 years	28 (80)	-
7	**Duration of work daily**		
	4-5 hours	35 (100)	7 (46.67)
	> 5 hours	-	8 (53.33)

Figures in parenthesis are percentages

The educational status of the street vendors indicated that only 5.71 per cent of the street vendors were educated up to high school level and 94.29 per cent were found to be educated only up to primary school level. In the case of restaurant workers, it was seen that 86.67 per cent were educated up to high school level and the rest (13.33%) were educated up to primary school level.

It was seen that all the restaurants obtained license from the Thrissur Corporation. However, in the case of street vendors, only 57.14 per cent obtained license from the Corporation for running the stall and the rest (42.86%) did not obtain any license from the Corporation.

With respect to the experience of running the stall it was seen that 80 per cent of the street vendors had an experience of more than five years in running the stall. About 11.43 per cent of street vendors and 86.67 per cent of restaurant workers had 2-5 years of experience and the rest of the street vendors (8.57%) and restaurant workers (13.33%) had less than two years of experience in their work.

Regarding the working hours it was seen that all the street vendors worked for 4-5 hours daily in their stalls while 46.67 per cent and 53.33 per cent of restaurant workers worked for 4-5 hours and more than five hours respectively in a day.

4.2. Practices adopted by the street vendors and restaurant workers

4.2.1. Cleaning practices adopted by the street vendors and restaurant workers

The details of cleaning practices adopted by the street vendors and restaurant workers are furnished in Table 2. It was seen that all the street vendors cleaned their stalls once in a day while 66.67 per cent of the restaurant workers cleaned the working area twice daily and rest of the restaurant workers cleaned the area once daily.

All the street vendors indicated that they used phenyl as the cleaning material and all the restaurant workers used lizol and dettol for cleaning the cooking area. All the street vendors and restaurant workers used BHC powder to keep away ants in the working area. To keep away rats, all the street vendors indicated that they used rat cage while all the restaurant workers used 'Rat kill' available in the market and 'Hit' to keep away cockroaches and other insects.

Table 2 – Cleaning practices adopted by the street vendors and restaurant workers

Sl.no	Details	Street vendors N=35	Restaurants workers N=15
1	**Frequency of cleaning the cooking area**		
	Once	35 (100)	5 (33.33)
	Twice	-	10 (66.67)
2	**Cleaning materials used**		
	Phenyl	35 (100)	-
	Lizol and dettol	-	15 (100)
3	**Disinfectants**		
	BHC powder	35 (100)	15 (100)
4	**Prevention of rodent menace**		
	Rat cage	35 (100)	-
	'Rat kill' and 'Hit'	-	15 (100)

Figures in parenthesis are percentages

4.2.2. Serving practices adopted by the street vendors and restaurant workers

The details regarding the serving practices adopted by the street vendors and restaurant workers are given in Table 3. All the street vendors and restaurant workers sold fresh fruit juices prepared from pineapple, lime, grapes, musambi and orange. Apart from these juices, pomegranate juice was also sold in restaurants.

Majority (94.29%) of the street vendors used glass tumblers to serve the fruit juices and the rest used both glass tumblers and disposable glasses to serve fruit juices whereas in restaurants, 66.67 per cent of the workers indicated that they used glass tumblers and the rest (33.33%) used only disposable glasses. All the restaurant workers and majority (85.71%) of the street vendors provided straws for the consumers for drinking fruit juices and used to dispose the straw after use.

Table 3- Serving practices adopted by the street vendors and restaurant workers

Sl.no	Details	Street vendors N= 35	Restaurant workers N = 15
1	**Types of fruit juices sold**		
	Pineapple, lime, grape, musambi and orange	35 (100)	15 (100)
	Pomegranate	-	15 (100)
2	**Type of tumblers used**		
	Glass	33 (94.29)	10 (66.67)
	Glass and Disposable	2 (5.71)	
	Disposable	-	5 (33.33)
3	**Usage of straw**		
	Provided straw	30 (85.71)	15 (100)
	Did not provide straw	5 (14.29)	-

Figures in parenthesis are percentages

4.2.3. Washing practices adopted by the street vendors and restaurant workers

All the street vendors and restaurant workers indicated that they washed the glasses before each use. The street vendors washed the glasses by simply dipping the used glasses in water while in restaurants the glasses were dipped, rinsed and wiped after washing. Majority (85.71%) of the street vendors wiped the washed

glasses. All the street vendors and restaurant workers washed the cloth used for wiping daily and in restaurants more than one cloth was used for wiping. In the restaurants the wiping clothes were dried under shade while 57.14 per cent of the street vendors dried the wiping cloth in sun and 42.86 per cent dried the cloth under shade. All the street vendors and restaurant workers indicated that they used to wash the glasses with soap and water daily after the day's work.

Table 4- Washing practices adopted by the street vendors and restaurant workers

Sl.no	Details	Street vendors N = 35	Restaurant workers N = 15
1	**Method of washing glasses after use**		
	Simply dipping in water	35 (100)	-
	Dipping in water and rinsing	-	15 (100)
2	**Wiping of washed glass**		
	Yes	30 (85.71)	15 (100)
	No	5 (14.29)	-
3	**Drying of wiping cloth**		
	Under sun	20 (57.14)	-
	Under shade	15 (42.86)	15 (100)

Figures in parenthesis are percentages

4.2.4. Water facilities available in the street vending sites and restaurants

The details regarding the water facilities are given in Table 5. All the restaurant workers used corporation water for juice preparation. Majority (74.29%) of the street vendors collected water from the public corporation taps in the nearby area and the rest (25.71%) collected water from nearby restaurants.

Majority (85.71%) of the street vendors stored the collected water in plastic buckets while in all the restaurants water was stored in plastic cans. Rest of the street vendors stored water in steel vessels.

All the street vendors and restaurant workers washed the storage containers and used fresh water daily for the preparation of fruit juices.

Table 5- Water facilities available in the street vending sites and restaurants

Sl.no	Details	Street vendors N= 35	Restaurant workers N= 15
1	**Source of water**		
	Corporation pipes/taps	26 (74.29)	15 (100)
	Nearby restaurants	9 (25.71)	-
2	**Storage of water**		
	Plastic cans	-	15 (100)
	Buckets	30 (85.71)	-
	Steel vessels	5 (14.29)	-

Figures in parenthesis are percentages

4.2.5. Hygienic conditions in and around the street vending stalls and restaurants

The hygienic conditions in and around the street vending stalls and restaurants is given in Table 6. It was seen that 57.14 per cent of the street vendors and all restaurant workers disposed garbage in separate pits whereas 42.86 per cent of the street vendors used to dispose garbage by burning. All the restaurant workers indicated that they disposed garbage twice in a day while all street vendors disposed garbage once daily.

Table 6- Hygienic conditions in and around the street vending stalls and restaurants

Sl.no	Details	Street vendors N= 35	Restaurant workers N = 15
1	**Method of garbage disposal**		
	Separate pits	20 (57.14)	15 (100)
	Others	15 (42.86)	-
2	**Frequency of garbage disposal**		
	Daily once	35 (100)	-
	Daily twice	-	15 (100)
3	**Garbage disposal facility**		
	Absent	3 (8.57)	-
	Present	32 (91.43)	15 (100)
4	**Menace of flies**		
	Absent	-	10 (66.67)
	Present	35 (100)	5 (33.33)
5	**Disturbance of dust**		
	Absent	-	15 (100)
	Present	35 (100)	-
6	**Foul smell**		
	Absent	17 (48.57)	15 (100)
	Present	18 (51.43)	-

Figures in parenthesis are percentages

Animals and stagnant pools were not observed around the street vending sites. However, flies and dust were observed in and around all the street vending stalls while flies were found only in 33.33 per cent of the restaurants. All the restaurants were found to be free from dust and foul smell while foul smell was detected from 51.43 per cent of the street vending stalls. All the restaurants and majority (91.43%) of the street vending stalls had proper garbage disposal facilities and the

rest (8.57%) of the street vending stalls did not have proper garbage disposal facilities.

4.2.6. Personal hygiene

Details on the personal hygiene of the vendors and restaurant workers are given in Table 7. All the street vendors and restaurant workers indicated that they used to wash their hands before and after preparing fruit juices. It was seen that only 26.67 per cent of the restaurant workers used separate napkin to wipe their hands after washing while none of street vendors used separate napkins to wipe their hands. All the restaurant workers and majority (85.71%) of the street vendors did not suffer from any diseases in the recent past while 14.29 per cent of the street vendors suffered from viral fever and cold. It was also seen that none of the street vendors and restaurant workers had gastro-intestinal disorders in the recent past.

With respect to vaccination taken against diseases, it was seen that 88.57 per cent of the street vendors and 66.67 per cent of the restaurant workers never knew whether they had taken vaccination for any diseases whereas 11.43 per cent and 33.33 per cent of street vendors and restaurant workers respectively indicated that they had not taken vaccination against any diseases.

It was seen that all restaurants had good toilet facilities while none of the street vending sites had proper toilet facilities.

All the restaurant workers were found to be neat and clean with their nails cut neatly and used head gears and aprons while only 54.29 per cent of the street vendors were found to be neat and 57.14 per cent cut their nails neatly. None of the street vendors used head gears and aprons. Regarding the use of gloves during their work it was seen that only 13.33 per cent of the restaurant workers used gloves while none of the street vendors and 86.67 per cent of restaurant workers never used gloves.

Table 7- Personal hygiene of the street vendors and restaurant workers

Sl.no	Personal hygiene	Street vendors N= 35	Restaurant workers N= 15
1	**Use of separate napkin to wipe hands**		
	Used separate napkins	-	4 (26.67)
	Did not use	35 (100)	11 (73.33)
2	**Recently suffered from any disease**		
	Suffered	5 (14.29)	-
	Did not suffer	30 (85.71)	15 (100)
3	**Vaccination against any disease**		
	No idea	31 (88.57)	10 (66.67)
	Not taken	4 (11.43)	5 (33.33)
4	**Good toilet facilities**		
	Present	-	15 (100)
	Absent	35 (100)	-
5	**Appearance**		
	Tidy	19 (54.29)	15 (100)
	Untidy	16 (45.71)	-
6	**Cleanliness of fingers**		
	Nails cut and neat	20 (57.14)	15 (100)
	Not neat	15 (42.86)	-
7	**Usage of head gears and apron**		
	Used head gears and aprons	-	15 (100)
	Did not use them	35 (100)	-
8	**Usage of gloves**		
	Used gloves	-	2 (13.33)
	Did not use gloves	35 (100)	13 (86.67)
9	**Beard**		
	Present	19 (54.29)	-
	Absent	16 (45.71)	15 (100)
10	**Moustache**		
	Present	5 (14.29)	10 (66.67)
	Absent	30 (85.71)	5 (33.33)

Figures in parenthesis are percentages

All the street vendors and restaurant workers used separate towels for their personal use. Moustache and beard were observed only among 14.29 per cent and 54.29 per cent of the street vendors respectively while 66.67 per cent of the restaurant workers had moustache and none had beard. All the restaurant workers combed their hair neatly while among the street vendors only 34.29 per cent combed their hair neatly. None of the vendors and restaurant workers had wounds on their hands.

4.2.7. Knowledge and washing habits of vendors

With respect to the knowledge of street vendors and restaurant workers on food borne diseases, their symptoms, safety aspects of consuming fast foods, necessity of washing hands and fruits before preparation and washing utensils and vessels before and after preparation it was seen that none of the street vendors and restaurant workers could name any food borne diseases except diarrhea. All the workers from both the sites indicated that fast food consumption is not safe for health. Positive responses with respect to washing of hands and fruits before preparation as well as washing of knives, cutting board, mixie, sieve and vessels before and after preparation were also indicated by all the respondents.

4.3. Consumption pattern of fruit juices by the consumers

Consumption pattern of beverages by the consumers with respect to the type, frequency and experience of consuming fresh fruit beverages and synthetic beverages, reasons for consumption, preference given and frequency of visit to the same vendor were collected and details are given in section 4.3.1 to 4.3.6.

4.3.1. Type of fruit juice consumed

The details regarding the type of fresh fruit juices consumed by the consumers are furnished in Table 8. From the street vending sites and restaurants, it was seen that the consumers used to take pineapple juice (37.14% and 36.67%), lime juice (28.57% and 26.67%), grape juice (20% and 16.67%), musambi juice (11.42% and 13.33%) and orange juice (2.86% and 6.67%).

Table 8- Type of fruit juices consumed

Sl.no	Details	Number of respondents	
		Street vending sites N= 70	**Restaurants N= 30**
1	**Types of fresh fruit juices**		
	Pineapple	26 (37.14)	11 (36.67)
	Lime	20 (28.57)	8 (26.67)
	Grape	14 (20)	5 (16.67)
	Musambi	8 (11.42)	4 (13.32)
	Orange	2 (2.86)	2 (6.67)

Figures in parenthesis are percentages

4.3.2. Cost of fresh fruit juices

The cost of pineapple juice sold in the all the street vending sites ranged from Rs.18-20 for 200 ml of juice while for the juice sold in restaurants ranged from Rs.25-30 for 250 ml of juice. In the case of grape juice, the cost was Rs.20 per 200 ml for juices sold in 94.29 per cent of the street vending sites and Rs.30 per 250 ml for juices sold by the other street vendors. In restaurants the cost was found to be Rs.35 per 250 ml of juice. Cost of lime juice was found to be in the range of Rs.6-8 for 200 ml juice for juices sold in 85.71 per cent of the street vending sites and Rs.10 per 200ml juice in the others while for the juices sold in the restaurants the cost was found to be Rs.15 per 250 ml of juice (86.67%) as given in Table 9.

Table 9- Cost of fruit juices sold in the street vending sites and restaurants

Sl.no	Details	Street vending Sites N= 35	Restaurants N= 15
1	**Pineapple juice**		
	Rs.18-20 for 200ml	35 (100)	-
	Rs.25-30 for 250ml	-	15 (100)
2	**Grape juice**		
	Rs.20 for 200ml	33 (94.29)	-
	Rs.30 for250ml	2 (5.71)	3 (20)
	Rs.35 for 250ml	-	12 (80)
3	**Lime juice**		
	Rs.6-8 for 200ml	30 (85.71)	-
	Rs.10 for 200ml	5 (14.29)	2 (13.33)
	Rs.15 for 250ml	-	13 (86.67)

Figures in parenthesis are percentages

4.3.3. Frequency and reason of fresh fruit juice consumption

The frequency of consumption and the reasons for consuming fruit juices are also furnished in the Table 10. Regarding the frequency of consumption of fruit juices, it was seen that 45.72 per cent of consumers coming to the street vending sites consumed fruit juices once in a month and 25.71 per cent consumed once in a week. Another 25.71 per cent indicated that they used to consume fruit juices rarely from the street vending sites. From the restaurants, 33.33 per cent of the consumers drank fruit juices rarely and 26.67 per cent once in a week. About 13.33 per cent indicated that they used to consume fruit juices from the restaurants once in a month and 26.67 per cent twice in a month.

Table 10- Frequency and reason for the fresh fruit juice consumption

Sl.no	Details	Number of respondents	
		Street vending sites N= 70	**Restaurants N= 30**
1	**Frequency of consumption**		
	Once a month	32 (45.72)	4 (13.33)
	Twice a month	2 (2.86)	8 (26.67)
	Once a week	18 (25.71)	8 (26.67)
	Rarely	18 (25.71)	10 (33.33)
2	**Reason for consumption**		
	Refreshment	56 (80)	24 (80)
	Others	14 (20)	6 (20)

Figures in parenthesis are percentages

Nearly 80 per cent of the consumers who drank fruit juices from street vending sites and restaurants indicated that they drank fruit juices for refreshment and the rest (20%) drank fruit beverages due to their taste and lack of time to prepare beverages at home. All the consumers indicated that they consumed one glass of fruit juice during each visit**.**

4.3.4. Frequency of visit to the same vendor, experience on consumption and consumption of synthetic beverages

With respect to the frequency of visit to the street vending sites 40 per cent of the consumers indicated that they used to visit the same site every time for consuming fruit juices while 57.14 per cent of the consumers visited the same vendor rarely (Table 11). In the case of restaurants nearly 50 per cent of the consumers indicated that they used to visit the same site rarely and 23.33 per cent visited the same site. Majority of the consumers coming to the street vending site (78.57%) and restaurants (93.33%) indicated that they did not have any problems

especially gastro-intestinal problems after consuming the fruit juices. Only 21.42 per cent and 6.67 per cent of the consumers who visited the street vending sites and restaurants respectively experienced problems due to the consumption of fruit juices.

Among the total consumers interviewed, it was seen that 71.43 per cent and 73.33 per cent who came to the street vending sites and restaurants respectively also consumed synthetic beverages from the same sites.

Table 11- Frequency of visit to the same vendor, experience on consumption and consumption of synthetic beverages

Sl.no	Details	Number of respondents	
		Street vending sites N= 70	**Restaurants N= 30**
1	**Frequency of visit to same vendor**		
	Every visit	28 (40)	7 (23.33)
	Rarely	40 (57.14)	15 (50)
	Very rarely	2 (2.86)	8 (26.67)
2	**Experience after consumption**		
	Good	55 (78.57)	28 (93.33)
	Bad	15 (21.43)	2 (6.67)
3	**Consumption of synthetic beverages**		
	Consumed synthetic beverages	50 (71.43)	22 (73.33)
	Did not consume	20 (28.57)	8 (26.67)

Figures in parenthesis are percentages

4.3.5. Types of synthetic beverages, frequency and experience of synthetic beverage consumption

The details on the type of synthetic beverages consumed, frequency of consumption of these beverages and experience on consuming the beverages are given in Table 12. Among the consumers who took synthetic beverages from the street vending sites, 40 per cent drank sherbet, 50 per cent drank *nannari* and 10 per cent drank syruped beverages. All the consumers who visited the restaurants for synthetic beverages drank syruped beverages.

Table 12- Types of synthetic beverages, frequency and experience of synthetic beverage consumption

Sl.no	Details	Number of respondents	
		Street vending sites N= 50	**Restaurants N= 22**
1	**Type of synthetic beverages consumed**		
	Sherbet	20 (40)	
	Nannari	25 (50)	
	Syruped beverages	5 (10)	22 (100)
2	**Frequency of consumption**		
	Rarely	5 (10)	14 (63.64)
	Very rarely	45 (90)	8 (36.36)
3	**Experience after consuming synthetic beverages**		
	Good	42 (84)	22 (100)
	Bad	8 (16)	

Figures in parenthesis are percentages

Regarding the frequency of consumption, it was seen that 90 per cent and 36.36 per cent of the consumers who came to the street vending sites and

restaurants took synthetic beverages very rarely. Only 16 per cent of the consumers experienced problems due to the consumption of synthetic beverages from the street vending sites.

4.3.6. Preference of the consumers between synthetic and fresh fruit juices and reason for preferences

With respect to the preference of fresh fruit beverages over synthetic beverages among the consumers it was seen that all the consumers who came to the street vending sites and restaurants preferred fresh fruit juices. Among this 74.29 per cent and 73.33 per cent of the consumers who came to the street vending sites and restaurants preferred fresh fruit juices because they were freshly prepared and rest (25.71% and 26.67%) gave preference due to their refreshing nature.

Table 13- Preference of the consumers between synthetic and fresh fruit juices and reason for preference

Sl.no	Details	Number of respondents	
		Street vending sites N= 70	**Restaurants N= 30**
1	**Preference given for beverages**		
	Preferred fresh fruit juices	70 (100)	30 (100)
	Preferred synthetic beverages	-	-
2	**Reason for preference**		
	More refreshing	18 (25.71)	8 (26.67)
	Freshly prepared	52 (74.29)	22 (73.33)

Figures in parenthesis are percentages

4.4. Quality evaluation of fresh fruit juices

4.4.1. Chemical constituents of fresh fruit juices

4.4.1.1. Acidity

The acidity of fruit juices collected from the six street vending sites is given in Table 14. The acidity of pineapple juice collected from all the sites was found to be uniform (0.380%) while, for grape juice the acidity varied from 0.540 to 0.570 per cent and for lime juice it varied from 0.190 to 0.250 per cent.

The acidity of grape juice collected from the three sites was found to be high (0.570%) in comparison with other sites as revealed by Kruskal-Wallis analysis of variance by ranks. In the case of lime juice, the acidity was found to be higher in the juices collected from two sites (S2 and S5) and was in variance with the juices collected from other four sites.

Table14- Acidity (%) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (†)	Grape juice (††)	Lime juice (††)
S1	0.380	0.540 (3.33)	0.190 (6.50)
S2	0.380	0.550 (5.83)	0.250 (15.50)
S3	0.380	0.550 (5.83)	0.190 (6.50)
S4	0.380	0.570 (14.00)	0.190 (6.50)
S5	0.380	0.570 (14.00)	0.250 (15.50)
S6	0.380	0.570 (14.00)	0.190 (6.50)

†- Kruskal-Wallis test not done as all the values are the same

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

Details regarding the acidity of fruit juices collected from the restaurants are furnished in Table 15. The acidity of pineapple juice collected from the four restaurants was found to be same (0.380%) and for grape juice it varied from 0.540 to 0.570 per cent. Highest acidity of 0.570 per cent was found in grape juice collected from one restaurant (R4). The acidity of lime juice varied from 0.190 to

0.193 per cent. Among the three juices collected from different restaurants highest variability in acidity was observed in grape juice on the basis of Kruskal-Wallis analysis of variance by ranks.

Table 15- Acidity (%) of fruit juices collected from restaurants

Restaurants	Pineapple juice (†)	Grape juice (††)	Lime juice(††)
R1	0.380	0.550 (5.50)	0.193 (8)
R2	0.380	0.550 (5.50)	0.190 (6)
R3	0.380	0.540 (4.00)	0.190 (6)
R4	0.380	0.570 (11.00)	0.190 (6)

† - Kruskal-Wallis not done as all the values are the same

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

Comparison of the mean acidity of fruit juices collected from the street vending sites and restaurants is given in Table 16 and Fig.1. The mean acidity of pineapple, grape and lime juices sold by street vendors was found to be 0.38 per cent, 0.56 per cent and 0.21 per cent respectively while the mean acidity of juices collected from restaurants was found to be 0.38 per cent (pineapple), 0.55 per cent (grape) and 0.19 per cent (lime).

Significant variation was observed in the acidity of lime juice collected from street vending sites and restaurants. The acidity of pineapple juice collected from restaurants and street vending sites was found to be the same.

Table 16- Comparison of the mean acidity of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Acidity (%)		t value
		Street vending sites	Restaurants	
1	Pineapple	0.38	0.38	†
2	Grape	0.56	0.55	1.66^{NS}
3	Lime	0.21	0.19	2.26**

† - t value not computed as all the values are the same

NS - Not significant

** - Significant at 5 per cent level

4.4.1.2. pH

The pH of pineapple, grape and lime juices collected from the street vending sites ranged from 3.200 to 3.360, 2.910 to 3.000 and 2.510 to 2.710 respectively (Table 17). The pH of pineapple juice collected from two sites was found to be higher with a rank score of 14.00 when compared with other four sites with rank scores varying from 2.00 to 11.50 as revealed by Kruskal-Wallis analysis of variance. For grape juice, the rank varied from 6.50 to 12.50 and the highest rank score of 12.50 was obtained for grape juice collected from two sites (S1 and S5). The pH of lime juice collected from one site was found to be higher (2.710) with a rank score of 12.83 in comparison with the lime juice collected from other sites.

Table 17- pH of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	3.200 (2.00)	3.000 (12.50)	2.530 (8.83)
S2	3.360 (11.50)	2.970 (9.50)	2.560 (11.67)
S3	3.400 (14.00)	2.970 (9.50)	2.510 (6.00)
S4	3.400 (14.00)	2.910 (6.50)	2.530 (8.83)
S5	3.310 (9.00)	3.000 (12.50)	2.710 (12.83)
S6	3.230 (6.50)	2.910 (6.50)	2.530 (8.83)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The pH of fruit juices collected from four restaurants is given in Table18. The pH of pineapple juice varied from 3.100 to 3.360 and the rank on the basis of Kruskal-Wallis analysis varied from 2.00 to 8.50. Highest pH of 3.000 was obtained for grape juice collected from three restaurants with a rank score of 7.00. In lime juice the pH varied from 2.500 to 2.800 and the pH of lime juice collected from two restaurants was found to be 2.660 with the rank score of 6.50.

Variability in the pH of pineapple and lime juices collected from most of the restaurants was observed based on Kruskal-Wallis analysis while for grape juice, the pH was found to be same for juice collected from three sites.

Table 18- pH of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice (††)	Lime juice (††)
R1	3.100 (2.00)	3.000 (7.00)	2.500 (4.50)
R2	3.300 (7.00)	3.000 (7.00)	2.800 (8.50)
R3	3.360 (8.50)	3.000 (7.00)	2.660 (6.50)
R4	3.360 (8.50)	2.960 (5.00)	2.660 (6.50)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The mean pH of the fruit juices collected from the street vending sites was found to be 3.32 (pineapple), 2.96 (grape) and 2.56 (lime) and from restaurants the pH was found to be 3.28 (pineapple), 2.99 (grape) and 2.66 (lime) (Table 19 and Fig.2).

Table 19- Comparison of the mean pH of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	pH		t value
		Street vending sites	Restaurants	
1	Pineapple	3.32	3.28	0.729^{NS}
2	Grape	2.96	2.99	1.60^{NS}
3	Lime	2.56	2.66	1.57^{NS}

NS – Not significant

The variation observed in the pH of three fruit juices collected from street vending sites and restaurants was found to be statistically insignificant.

4.4.1.3. TSS

Details regarding the TSS of fruit juices collected from the street vending sites are given in Table 20. The TSS of pineapple, grape and lime juices varied from 25 to 26.270, 24.870 to 30 and 16.800 to 18ºbrix respectively. Based on the Kruskal-Wallis analysis of variance by ranks, TSS of pineapple juice collected

Fig.1. Comparison of the mean acidity of fruit juices collected from street vending sites and restaurants

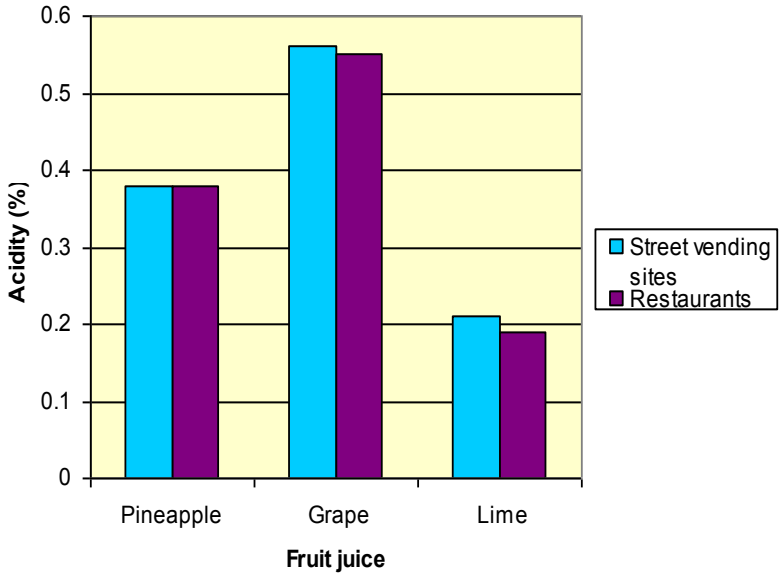
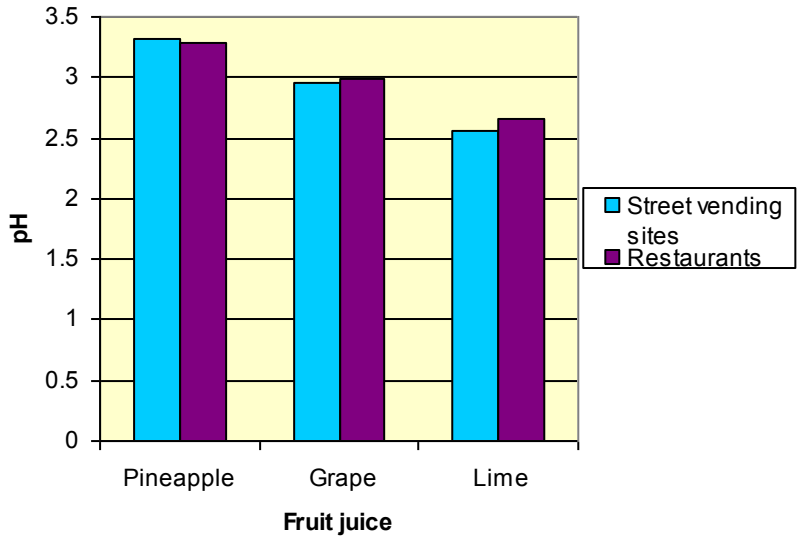


Fig.2. Comparison of the mean pH of fruit juices collected from street vending sites and restaurants



from one site (S2) was found to be higher in comparison with other sites. In the case of grape juice the TSS was found to be same which were collected from five sites with a rank score of 11. For lime juice, maximum TSS of 18°brix with a rank score of 17.00 was obtained for the juice collected from one street vending site and lowest TSS with the lowest rank score of 3.50 was obtained in the juice collected from two sites (S4 and S6). More variability in TSS was observed in pineapple juice collected from different street vending sites

Table 20- TSS (°brix) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	25.930 (12.00)	30.000 (11.00)	17.000 (11.00)
S2	26.270 (15.00)	24.870 (2.00)	18.000 (17.00)
S3	25.330 (7.50)	30.000 (11.00)	17.000 (11.00)
S4	26.000 (13.50)	30.000 (11.00)	16.800 (3.50)
S5	25.000 (4.50)	30.000 (11.00)	17.000 (11.00)
S6	25.000 (4.50)	30.000 (11.00)	16.800 (3.50)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The TSS of pineapple, grape and lime juice collected from the restaurants ranged from 25.670 to 26, 28.670 to 30 and 16.500 to 17°brix respectively as shown in Table 21. The TSS of pineapple juice and grape juice collected from R3 and R4 was found to be the lowest with a rank score of 3.50 when compared to the TSS of juices collected from other sites with a rank score of 7.50 as revealed by the Kruskal-Wallis analysis of variance by ranks. The TSS of lime juice collected from the restaurants varied from 16.500 to 17.000°brix with rank scores in the range of 4.00 to 10.00.

On the basis of Kruskal-Wallis analysis, variability of TSS was observed in pineapple juice collected from R3 and for grape juice collected from R4. For lime juice the TSS was found to be the same which were collected from R1 and R2 and variability was observed in the juice collected from the other two sites.

Table 21- TSS (°brix) of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice (††)	Lime juice (††)
R1	26.000 (7.50)	30.000 (7.50)	16.670 (6.00)
R2	26.000 (7.50)	30.000 (7.50)	16.670 (6.00)
R3	25.670 (3.50)	30.000 (7.50)	16.500 (4.00)
R4	26.000 (7.50)	28.670 (3.50)	17.000 (10.00)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The mean TSS of the selected three fruit juices sold in the street vending sites and restaurants is given in Table 22 and Fig.3. The TSS of the fruit juices in the street vending sites varied from 17.10ºbrix to 29.14ºbrix with the highest TSS in grape juice and lowest in lime juice. The TSS of the fruit juices collected from the restaurants varied from 16.71ºbrix (lime juice) to 29.67ºbrix (grape juice). The variation observed in the TSS content of pineapple and lime juices collected from the street vending sites and restaurants were found to be statistically significant while for grape juice the variation was found to be statistically insignificant.

Table 22- Comparison of the mean TSS of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	TSS (°brix)		t value
		Street vending sites	Restaurants	
1	Pineapple	25.59	25.91	1.89*
2	Grape	29.14	29.67	0.87^{NS}
3	Lime	17.10	16.71	2.85***

* - Significant at ten per cent level

*** - Significant at one per cent level

NS- Not significant

4.4.1.4. Total sugar

Total sugar content of the fruit juices collected from the street vending sites is furnished in Table 23. The total sugar content of pineapple, grape and lime juices varied from 22.700 to 25.000, 24.300 to 28.400 and 16.100 per cent with rank scores ranging from 5.00 to 14.00 for pineapple juice and 2.00 to 13.88 for grape juices.

The total sugar content of pineapple juice collected from three sites namely S1, S2 and S4 was found to be same (25%) with a rank score of 14.00 and the total sugar content of pineapple juice collected from the other three sites was found to be 22.700 per cent with a rank score of 5.00. Variability was not observed in the total sugar content of grape juice collected from four sites namely S1, S4, S5 and S6 while the variability observed in the total sugar content of grape juice collected from two sites (S2 and S3) was found to be statistically significant. In the case of lime juice the total sugar content was found to be uniform which were collected from different sites.

Table 23- Total sugar content (%) of fruit juices collected from street vending sites

Street vending site	Pineapple juice (††)	Grape juice (††)	Lime juice (†)
S1	25.000 (14.00)	28.200 (10.50)	16.100
S2	25.000 (14.00)	24.300 (2.00)	16.100
S3	22.700 (5.00)	28.400 (13.88)	16.100
S4	25.000 (14.00)	28.200 (10.50)	16.100
S5	22.700 (5.00)	28.200 (10.50)	16.100
S6	22.700 (5.00)	28.200 (10.50)	16.100

†- Kruskal-Wallis analysis not done as all the values are the same.

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The total sugar content of pineapple juice collected from four restaurants was found to be 25 per cent while for lime juice the content was found to be

16.100 per cent. The total sugar content of grape juice collected the restaurants varied from 25 to 28.200 per cent with a rank score of 3.50 and 9.50 respectively. The details are given in Table 24.

Variability observed in the total sugar content of pineapple and lime juices collected from the restaurants was found to be statistically insignificant while variability was observed in the total sugar content of grape juice.

Table 24- Total sugar content (%) of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice(††)	Lime juice (†)
R1	25.000	28.200 (9.50)	16.100
R2	25.000	28.200 (9.50)	16.100
R3	25.000	25.000 (3.50)	16.100
R4	25.000	25.000 (3.50)	16.100

†- Kruskal-Wallis not done as the values are the same

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The mean total sugar content of the pineapple, grape and lime juices sold by the street vendors was found to be 23.85 per cent, 27.58 per cent and 16.10 per cent while for juices collected from restaurants the total sugar content was found to be 25 per cent, 26.60 per cent and 16.10 per cent respectively. The details are furnished in Table 25 and Fig.4.

Variation observed in the mean total sugar content of pineapple juice collected from the street vending sites and restaurants was found to be statistically significant while for grape juice the variation observed was found to be statistically insignificant.

Fig.3. Comparison of the mean TSS of fruit juices collected from street vending sites and restaurants

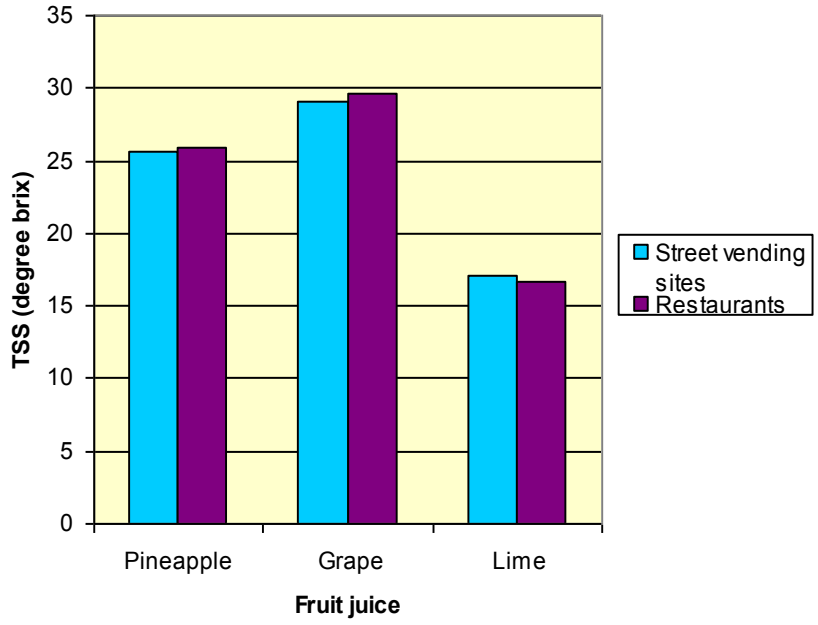


Fig.4. Comparison of the mean total sugar content of fruit juices collected from street vending sites and restaurants

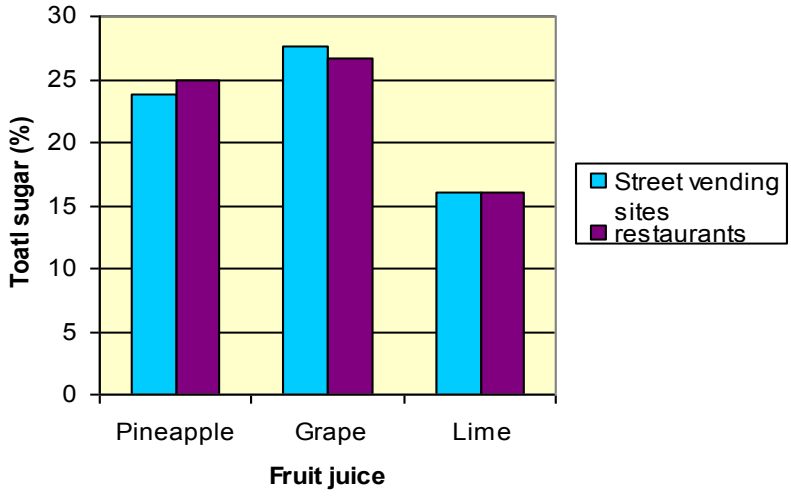


Table 25- Comparison of the mean total sugar content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Total sugar (%)		t value
		Street vending sites	Restaurants	
1	Pineapple	23.85	25	3.34***
2	Grape	27.58	26.60	1.67^{NS}
3	Lime	16.10	16.10	+

+ - t value not computed as all the values are the same

NS- not significant

*** - Significant at one per cent level

4.4.1.5. Reducing sugar

The reducing sugar content of pineapple, grape and lime juices collected from the street vending sites varied from 18.18 to 20 per cent, 22 to 22.200 per cent and 10 to 12 per cent (Table 26). Reducing sugar content of pineapple juice was found to be higher in the juice collected from one street vending site (S3) with a rank score of 17.00 when compared to the juices collected from other sites with a rank score of 8.00. The reducing sugar content of grape juice collected from one site (S5) was found to be low (22%) with a rank score of 2.00 in comparison with the grape juice collected from other sites with a reducing sugar content of 22.200 per cent and rank score of 11.00. In the case of lime juice, highest reducing sugar content (12%) was observed in the juice collected from one site (S4) with a rank of 17.00. The reducing sugar content of lime juice collected from four sites was found to be same.

On the basis of Kruskal-Wallis analysis of variance, variability in the reducing sugar content of both pineapple and grape juices was not observed except in juices collected from S3 and S5 respectively. Variability in the reducing sugar content of lime juice was observed only in juices collected from two sites namely S4 and S6.

Table 26- Reducing sugar content(%) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	18.180 (8.00)	22.200 (11.00)	10.000 (7.00)
S2	18.180 (8.00)	22.200 (11.00)	10.000 (7.00)
S3	20.00 (17.00)	22.200 (11.00)	10.000 (7.00)
S4	18.180 (8.00)	22.200 (11.00)	12.000 (17.00)
S5	18.180 (8.00)	22.000 (2.00)	10.000 (7.00)
S6	18.180 (8.00)	22.200 (11.00)	11.800 (12.00)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The details regarding the reducing sugar content of fruit juices collected from the restaurants are given in Table 27. In pineapple juice, the reducing sugar content varied from 18.180 to 20 per cent with a rank score varying from 2.00 to 8.00. The content was found to be same in pineapple juice collected from three sites. The reducing sugar content of grape and lime juices collected from all the four restaurants were found to be 22.200 per cent and 10 per cent respectively.

On the basis of statistical analysis, variability was observed in the reducing sugar content of pineapple juice collected from one restaurant (R4).

Table 27- Reducing sugar content (%) of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice (†)	Lime juice (†)
R1	20.000 (8.00)	22.200	10.000
R2	20.000 (8.00)	22.200	10.000
R3	20.000 (8.00)	22.200	10.000
R4	18.180 (2.00)	22.200	10.000

†- Kruskal-Wallis not done as all the values are the same

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

Comparison of the mean reducing sugar content of the fruit juices collected from the street vending sites and restaurants is given in Table 28 and Fig.5. The mean reducing sugar content of pineapple, grape and lime juices collected from the street vendors were found to be 18.48 per cent, 22.16 per cent and 10.63 per cent respectively. The mean reducing sugar content of juices collected from restaurants was found to be 19.54 per cent (pineapple), 22.200 per cent (grape) and 10 per cent (lime).

Variation observed in the reducing sugar content of pineapple and lime juices collected from street vending sites and restaurants was found to be statistically significant while in the case of grape juice the variation was found to be statistically insignificant.

Table 28- Comparison of the mean reducing sugar content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Reducing sugar (%)		t value
		Street vending sites	Restaurants	
1	Pineapple	18.48	19.54	3.80***
2	Grape	22.16	22.20	1.49^{NS}
3	Lime	10.63	10	2.05**

** - Significant at five per cent level

*** - Significant at one per cent level

NS- Not significant

4.4.1.6. Non- reducing sugar

The non-reducing content of pineapple, grape and lime juices collected from the street vending sites varied from 2.700 to 6.200, 2.270 to 6.200 and 4.100 to 6.100 per cent with corresponding rank scores ranging from 2.50 to 14.00, 2.00 to 15.50 and 3.00 to 12.00 (Table 29). Statistically, variability was not observed in the non-reducing sugar content of pineapple juice collected from three sites

namely S1, S2 and S4 whereas the variability was observed in the pineapple juice collected from S3, S5 and S6.

Table 29- Non-reducing sugar content (%) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	6.200 (14.00)	6.000 (9.50)	6.100 (12.00)
S2	6.200 (14.00)	2.270 (2.00)	6.100 (12.00)
S3	2.700 (2.50)	6.120 (14.33)	6.100 (12.00)
S4	6.200 (14.00)	6.000 (9.50)	4.100 (3.00)
S5	3.900 (7.00)	6.200 (15.50)	6.100 (12.00)
S6	3.500 (5.50)	3.870 (6.17)	4.770 (6.00)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

Extreme variability was observed in the non-reducing sugar content of grape juice collected from the street vending sites while for lime juice variability was not noticed in the non-reducing sugar content of juices collected from four sites namely S1, S2, S3 and S5.

Non-reducing content of pineapple, grape and lime juices collected from restaurants varied from 5.000 to 6.200 per cent, 2.800 to 6.000 per cent and 5.93 to 6.270 per cent respectively (Table 30). The non-reducing sugar content of pineapple juice collected from R4 was found to be high when compared to other sites in which the non-reducing sugar content was found to be the same. In the case of grape juice, variability was not observed in the juices collected from three restaurants namely R1, R3 and R4 in which the content was found to be 6 per cent with a rank score of 8.00. Variability in the non-reducing sugar content of lime juice collected from the restaurants was noticed with a higher content collected from R2 and lower content in the juice collected from R3.

Table 30- Non-reducing sugar content (%) of fruit juices collected from restaurants

Restaurants	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
R1	5.000 (5.00)	6.000 (8.00)	6.100 (6.50)
R2	5.000 (5.00)	2.800 (2.00)	6.270 (8.33)
R3	5.000 (5.00)	6.000 (8.00)	5.930 (4.67)
R4	6.200 (11.00)	6.000 (8.00)	6.100 (6.50)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The mean non-reducing content of the fruit juices collected from the street vending sites and restaurants are given in Table 31 and Fig.6. The mean non-reducing content of pineapple, grape and lime juices collected from the street vendors was found to be 4.78 per cent, 5.08 per cent and 5.54 per cent respectively while those collected from the restaurants was found to be 5.03 per cent, 5.20 per cent and 6.10 per cent respectively.

Table 31- Comparison of the mean non-reducing sugar content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Non-reducing sugar (%)		t value
		Street vending sites	Restaurants	
1	Pineapple	4.78	5.03	1.34^{*}
2	Grape	5.08	5.20	0.18^{NS}
3	Lime	5.54	6.10	2.04*

NS- Not significant

*- Significant at ten per cent level

Variation observed in the non-reducing sugar content of pineapple and lime juices collected from the street vending sites and restaurants was found to be statistically significant while for grape juice the variation was found to be statistically insignificant.

Fig.5. Comparison of the mean reducing sugar content of fruit juices collected from street vending sites and restaurants

Fig.6. Comparison of the mean non-reducing sugar content of fruit juices collected from street vending sites and restaurants

4.4.1.7. Vitamin C

The vitamin C content of pineapple, grape and lime juices collected from the street vending sites varied from 7.500 to 9.330, 5.070 to 5.400 and 3.170 to 3.700 mg per 100ml respectively. The vitamin C content of pineapple juice collected from one site (S5) was found to be the high with a rank score of 15.67 and in other five sites the rank scores varied from 6.50 to 13.17 as revealed by Kruskal-Wallis analysis of variance. For grape juice, the vitamin C content was highest in the juice collected from S4 with a rank of 12.00 when compared to the other sites with ranks varying from 6.00 to 11.17. The vitamin C content of lime juice collected from two sites(S3 and S4) was found to be lower with a rank score of 7.33and 7.67 in comparison with the lime juice collected from other sites as revealed by Kruskal-Wallis analysis of variance by ranks.

Table 32- Vitamin C content (mg100ml^{-1}) of fruit juices collected from street vending sites

Street vending site	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	7.500 (6.50)	5.070 (6.00)	3.700 (10.50)
S2	7.500 (6.50)	5.090 (8.17)	3.700 (10.50)
S3	8.830 (13.17)	5.140 (11.17)	3.370 (7.67)
S4	7.500 (6.50)	5.400 (12.00)	3.170 (7.33)
S5	9.330 (15.67)	5.120 (9.83)	3.700 (10.50)
S6	7.670 (8.67)	5.120 (9.83)	3.700 (10.50)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

Variability in the vitamin C content was observed in pineapple juice collected from three street vending sites. In the case of grape juice, more variability was observed with respect to vitamin C content in the juices collected from different sites except those collected from S5 and S6. Variability in the vitamin C content of lime juice collected from four street vending sites was found to be same.

The vitamin C content of fruit juices collected from the restaurants are given in Table 33. The vitamin C content of pineapple, grape and lime juices varied from 7.330 to 9.700, 5.031 to 5.570 and 2.500 to 3.700mg per 100ml with rank scores ranging from 4.00 to 11.00, 4.33 to 11.00 and 2 to 8 respectively.

Table 33- Vitamin C content (mg100ml^{-1}) of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice (††)	Lime juice(††)
R1	7.330 (4.00)	5.570 (11.00)	2.500 (2.00)
R2	7.600 (5.50)	5.031 (4.33)	3.700 (8.00)
R3	9.700 (11.00)	5.100 (5.67)	3.700 (8.00)
R4	7.600 (5.50)	5.060 (5.00)	3.700 (8.00)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

On the basis of ranks given by the Kruskal-Wallis analysis, the vitamin C content of pineapple juice collected from two restaurants (R2 and R4) was found to be same. Variability was observed in the vitamin C content of pineapple juice collected from other two sites. More variability was observed in the vitamin C content of grape juice collected from all the four restaurants. The vitamin C content of lime juice collected from three restaurants was found to be same (3.700mg/100ml) with a rank score of 8.00 and this varied significantly with the vitamin C content of lime juice collected from R1.

The mean vitamin C content of pineapple, grape and lime juices collected from the street vending sites was found to be 8.05 mg, 5.15 mg and 3.55 mg 100ml^{-1} respectively. The mean vitamin C content of the fruit juices collected from restaurants was found to be 8.05 mg 100ml^{-1} (pineapple), 5.19 mg 100ml^{-1} (grape) and 3.40 mg 100ml^{-1} (lime). The details are furnished in Table 34 and Fig.7.

The variation observed in the vitamin C content of grape and lime juices collected from the street vending sites and restaurants was found to be statistically insignificant.

Table 34- Comparison of the mean vitamin C content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Vitamin C(mg/100ml)		t value
		Street vending sites	Restaurants	
1	Pineapple	8.05	8.05	+
2	Grape	5.15	5.19	3.33^{NS}
3	Lime	3.55	3.40	0.87^{NS}

+ - t value not computed as the values are the same

NS – Not significant

4.4.1.8. β carotene

The β carotene content of pineapple, grape and lime juices collected from the street vending sites varied from 2.771 to 3.437, 0.221 to 0.553 and 1.108 to 1.718 µg per 100ml respectively. The β carotene content of pineapple juice collected from one street vending site (S4) was found to be higher with a rank score of 14.33 when compared with other five sites with rank scores ranging from 2.67 to 12.67 as revealed by Kruskal-Wallis analysis of variance. For grape juice the ß carotene content was found to be high in the juice collected from two street vending sites (S4 and S5) with a rank score of 12.83. In lime juice the highest β carotene content was noticed in the juice collected from one site (S6) and the β carotene content was found to be the same (1.441µg $100ml^{-1}$) in juices collected from two sites namely S3 and S5.

More variability in the β carotene content of pineapple juice collected from street vending sites was observed while in the case of grape and lime juice variability was not observed in juices collected from two sites (Table 35).

Table 35 –β carotene content (µg 100ml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	2.771 (2.67)	0.387 (7.67)	1.551 (10.33)
S2	3.326 (11.33)	0.443 (10.00)	1.108 (3.17)
S3	3.270 (10.50)	0.221 (3.67)	1.441 (8.17)
S4	3.437 (14.33)	0.553 (12.83)	1.662 (12.83)
S5	3.049 (5.50)	0.553 (12.83)	1.441 (8.17)
S6	3.381 (12.67)	0.443 (10.00)	1.718 (14.33)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The β carotene content of pineapple, grape and lime juices collected from restaurants ranged from 2.937 to 3.548, 0.276 to 0.553 and 1.385 to 1.496 µg per 100ml with rank scores ranging from 5.50 to 14.56, 7.50 to 12.83 and 4.50 to 8.80.

Table 36- β carotene (µg 100ml^{-1}) content of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice(††)	Lime juice (††)
R1	3.548 (14.56)	0.553(12.83)	1.441 (8.12)
R2	3.104 (11.33)	0.609 (10.00)	1.496 (8.80)
R3	3.104 (11.33)	0.276 (7.50)	1.385 (4.50)
R4	2.937 (5.50)	0.553 (12.83)	1.496 (8.80)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

On the basis of Kruskal-Wallis analysis of variance, variability of β carotene content in pineapple and grape juices was not observed in the juices collected from R2 and R3 as also from R1 and R4. For lime juice also the variability was not observed in the juices collected from two restaurants (R2 and R4).

Comparison of the mean β carotene content of fruit juices sold by the street vendors and restaurants are shown in Table 37 and Fig.8. The mean β carotene content of the fruit juices from the street vending sites varied from 0.43 to 3.20 µg per 100 ml while the ß carotene content in fruit juices collected from the restaurants varied from 0.49 to 3.09 µg per 100ml.

Table 37- Comparison of the mean β carotene content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	B carotene(µg100ml^{-1})		t value
		Street vending sites	Restaurants	
1	Pineapple	3.20	3.09	1.08^{NS}
2	Grape	0.43	0.49	0.94^{NS}
3	Lime	1.48	1.45	0.35^{NS}

NS – Not significant

The variation in the mean ß carotene content of the three fruit juices collected from the street vending sites and restaurants was found to be statistically insignificant.

4.4.1.9. Sodium

Sodium content observed in pineapple juice collected from the six street vending sites varied from 2 to 2.170 mg per 100 ml with a rank score in the range of 6.00 to 12.67. In grape juice, sodium was present in juices collected from three sites namely S1, S4 and S5 which varied from 0.060 to 0.170 mg per 100ml. Sodium was not observed in lime juice collected from any of the sites as given in Table 38.

Variability was observed in the sodium content of both pineapple and grape juices collected from the street vending sites.

Fig.7. Comparison of the mean vitamin C content of fruit juices collected from street vending sites and restaurants

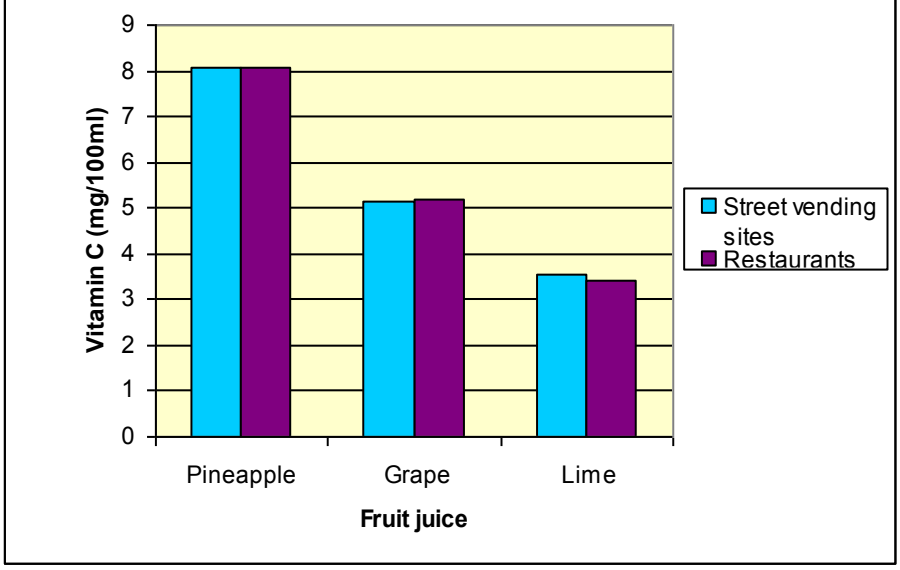


Fig.8. Comparison of the mean Beta carotene content of fruit juices collected from street vending sites and restaurants

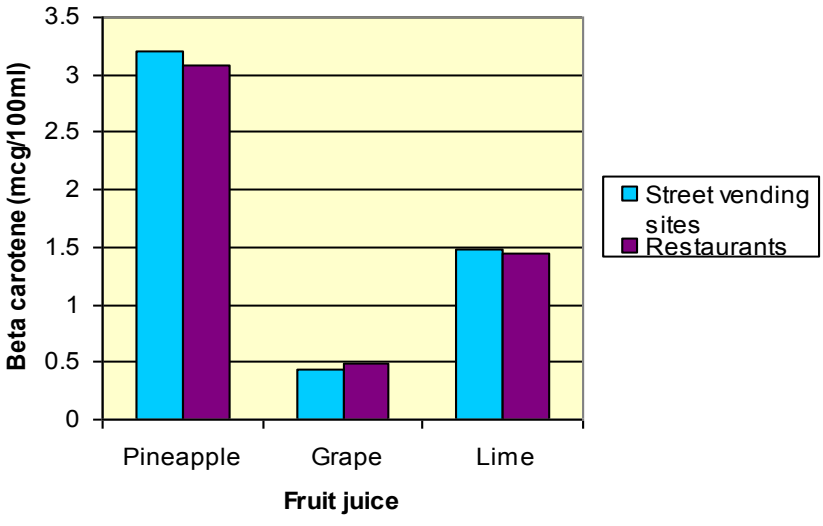


Table 38- Sodium content (mg100ml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (†)
S1	2.070 (9.33)	0.170 (15.83)	0
S2	2.000 (6.00)	0	0
S3	2.130 (12.67)	0	0
S4	2.000 (6.00)	0.100 (13.50)	0
S5	2.030 (8.17)	0.060 (9.67)	0
S6	2.170 (14.83)	0	0

†- Kruskal-Wallis analysis not done as the values are the same

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

Out of the three fruit juices collected from the restaurants, sodium content was present only in pineapple juice which varied from 2.000 to 2.170 mg per 100ml with rank scores ranging from 4.50 to 10.83. Variability in the sodium content of pineapple juice was observed which were collected from two sites namely R3 and R4 while the sodium content of pineapple juice collected from R1and R2 were found to be same.

Table 39- Sodium content (mg100ml^{-1}) of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice (†)	Lime juice (†)
R1	2.000 (4.50)	0	0
R2	2.000 (4.50)	0	0
R3	2.030 (6.17)	0	0
R4	2.170 (10.83)	0	0

†- Kruskal-Wallis not done as all the values are the same.

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The mean sodium content of pineapple and grape juices sold by the street vendors was found to be 2.06 and 0.055mg per 100 ml respectively. The sodium

content of pineapple juice collected from the street vendors and restaurants was found to be statistically insignificant while the variation observed in the sodium content of grape juice collected from street vendors and restaurants was found to be statistically significant. Details are furnished in Table 40 and Fig.9.

Table 40- Comparison of the mean sodium content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Sodium(mg100ml^{-1})		t value
		Street vending sites	Restaurants	
1	Pineapple	2.06	2.05	0.516^{NS}
2	Grape	0.055	0	2.44**
3	Lime	0	0	+

NS- Not significant

** - Significant at five per cent level

+ - t value not computed as all the values are the same

4.4.1.10. Potassium

Potassium content of pineapple, grape and lime juices collected from the street vending sites varied from 1.970 to 2.100 mg, 0 to 0.200 mg and 7.930 to 8.030 mg per 100ml with rank score ranging from 6.00 to 17.00, 15.00 to 16.00 and 4.33 to 12.67 as revealed by Kruskal-Wallis analysis of variance by ranks. The details are furnished in Table 41.

Table 41 – Potassium content (mg 100ml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice (††)	Grape juice (††)	Lime juice (††)
S1	2.100 (17.00)	0.200 (16.00)	8.00 (10.00)
S2	2.000 (8.50)	0	8.00 (10.00)
S3	2.000 (8.50)	0	8.03 (12.67)
S4	2.000 (8.50)	0	7.93 (4.33)
S5	2.000 (8.50)	0.170 (15.00)	8 (10.00)
S6	1.970 (6.00)	0	8 (10.00)

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The potassium content of pineapple juice collected from four sites was found to be same (2mg/100ml) with same rank score of 8.50. Variability in the

potassium content of grape juice was observed which were collected from two sites. In lime juice, the potassium content was found to be same (8 mg/100ml) which were collected from four sites.

Potassium content of pineapple juice and lime juice collected from restaurants varied from 2.000 to 2.070mg and 7.5 to 8mg with rank scores ranging from 5.00 to 9.00 and 2.00 to 8.00. Potassium content was not observed in grape juice collected from any of the restaurants. Variability was observed in the potassium content of pineapple juice collected from R2 and R3 while for lime juice the potassium content was found to be same in the juice collected from three sites (Table 42).

Table 42 – Potassium content (mg100ml^{-1}) of fruit juices collected from restaurants

Restaurants	Pineapple juice(††)	Grape juice (†)	Lime juice (††)
R1	2.000 (5.00)	0	7.500 (2.00)
R2	2.030 (7.00)	0	8.000 (8.00)
R3	2.070 (9.00)	0	8.000 (8.00)
R4	2.000 (5.00)	0	8.000 (8.00)

†- Kruskal-Wallis not done as all the values are the same.

††- Figures in parenthesis indicate mean rank as per Kruskal -Wallis test

The mean potassium content of pineapple, grape and lime juices collected from street vending sites was found to be 2.01, 0.06 and 7.99 mg per 100ml and those collected from restaurants was found to be 2.02, 0 and 7.87 mg per 100ml respectively. The details are furnished in Table 43 and Fig10.

Significant variation was observed in the potassium content of grape and lime juices collected from the street vending sites and restaurants while the variation was found to be statistically insignificant in case of pineapple juice collected from the two sites.

Fig.9. Comparison of the mean sodium content of fruit juices collected from street vending sites and restaurants

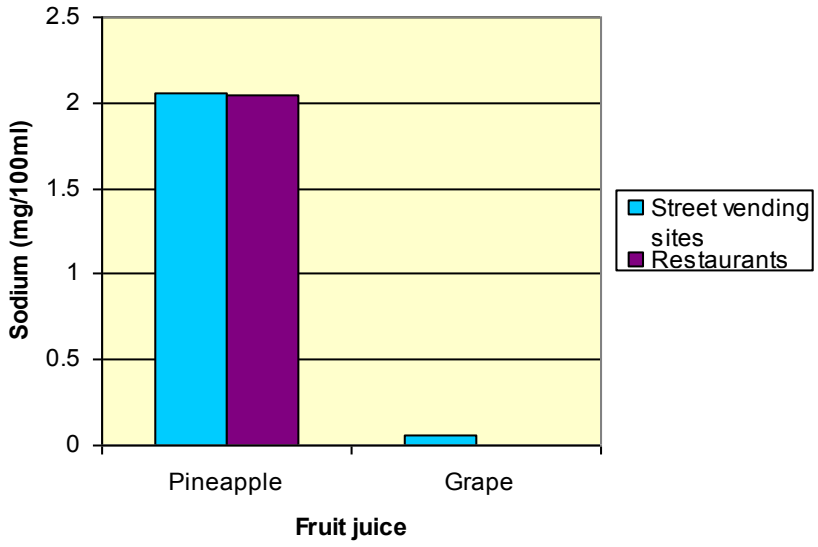


Fig. 10. Comparison of the mean potassium content of fruit juices collected from street vending sites and restaurants

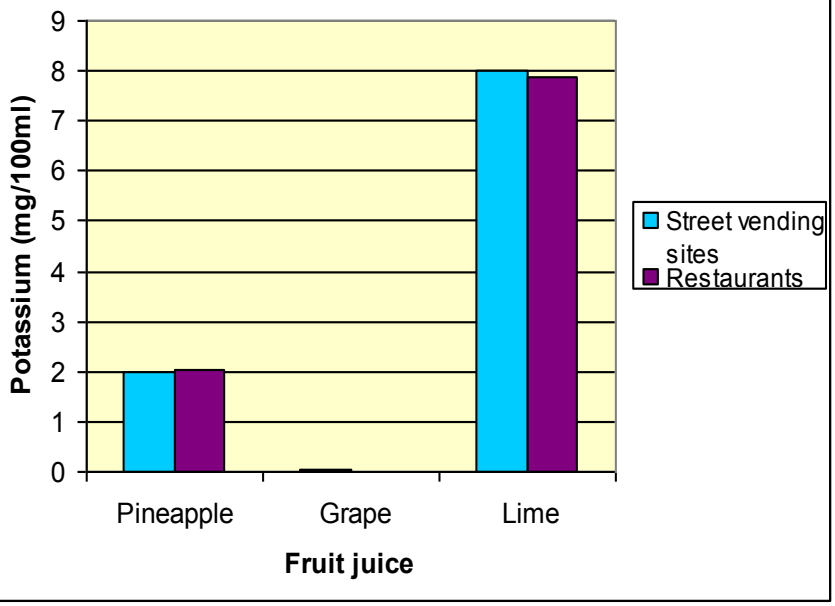


Table 43- Comparison of the mean potassium content of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Potassium (mg/100ml)		t value
		Street vending sites	Restaurants	
1	Pineapple	2.01	2.02	0.50NS
2	Grape	0.06	0	2.29**
3	Lime	7.99	7.87	2.20**

NS- Not significant

** - Significant at five per cent level

4.4.1.11. Food colours (Qualitative)

Food colours were not detected in any of the fresh fruit juices collected from the street vending sites and restaurants.

4.4.2. Enumeration of microorganisms in fresh fruit juices

Enumeration of microorganisms in fresh fruit juices collected from street vending sites and restaurants like bacteria, yeast, fungi and other pathogenic microorganisms was conducted and the results are presented in 4.4.2.1 to 4.4.2.5.

4.4.2.1. Bacteria

The bacterial count of pineapple juice, grape juice and lime juice collected from the street vending sites varied from $89.33x10^6$ to $204x10^6$ cfu per ml, $36.66x10^6$ to $104.33x10^6$ cfu per ml and $61.66x10^6$ to $93x10^6$ cfu per ml with a mean count of $141.05x10^6$, $76.05x10^6$ and $77.22x10^6$ cfu per ml (Table 44).

On the basis of one way analysis of variance the bacterial count of pineapple juice collected from six street vending sites varied significantly except in two sites namely S5 and S6. Based on bacterial count, the grape juice collected from six sites was grouped into three subgroups. The lime juice collected from the six street vending sites was grouped into two subgroups.

Table 44 -Bacterial count (x10^6cfu ml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice	Grape juice	Lime juice
S1	118.33^{d}	95.33^{a}	61.66^{b}
S2	187.33^{b}	76.33^{b}	86.66^{a}
S3	204.00^{a}	73.00^{b}	90.00^{a}
S4	152.66^{c}	104.33^{a}	67.00^{b}
S5	94.66^{e}	70.66^{b}	65.00^{b}
S6	89.33^{e}	36.66^{c}	93.00^{a}
Mean	141.05	76.05	77.22

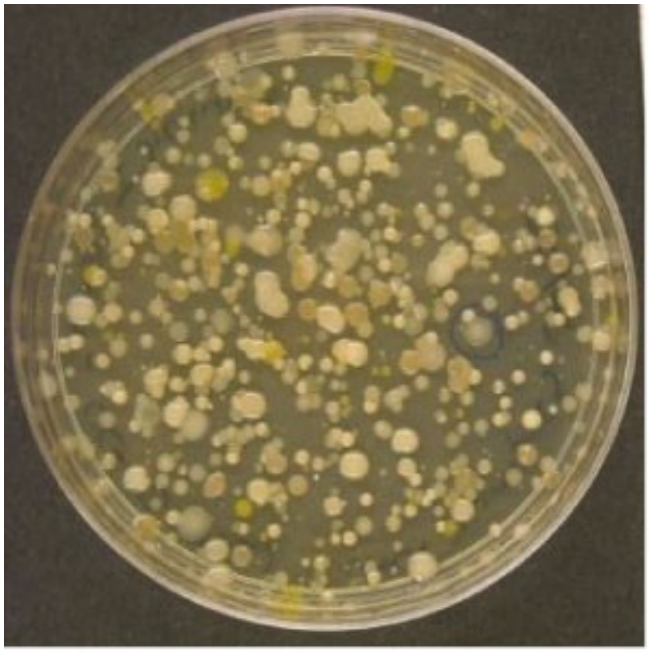
Figures with even superscripts form one homogenous group

The mean bacterial count of fruit juices collected from restaurants was found to be 73.58x10^6 (pineapple), 53.91x10^6 (grape) and 51.16x10^6 (lime juice) cfu per ml. The bacterial count of pineapple juice collected from four restaurants varied from 56.67x10^6 to 96x10^6 cfu per ml. The bacterial count of pineapple juice collected from R3 and R4 varied significantly from the counts observed from other two sites. The bacterial count of pineapple juice collected from R1 and R2 was found to be statistically insignificant.

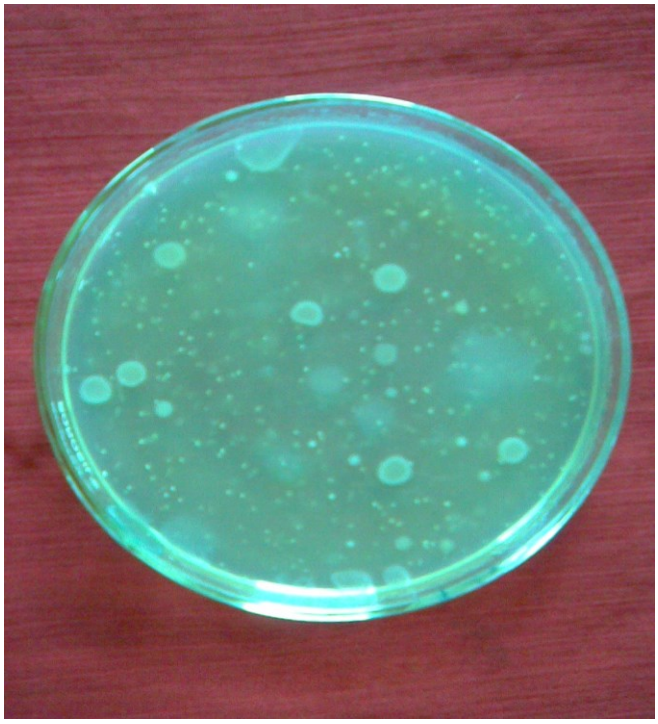
The bacterial count of grape juice varied from 31x10^6 to 74.67x10^6 cfu per ml. The highest bacterial count was observed in grape juice collected from R1 and the count varied significantly from the count observed in grape juice collected from other three restaurants.

The bacterial count of lime juice varied from 39.33x10^6 to 67.67x10^6 cfu per ml. The bacterial count observed in lime juice collected from R3 was found to be significantly different from the bacterial count of juices collected from R2 and R4 whereas it was on par with the bacterial count of the fruit juice collected from R1.

Plate.1. Bacterial growth in pineapple juice collected from street vending site and restaurant

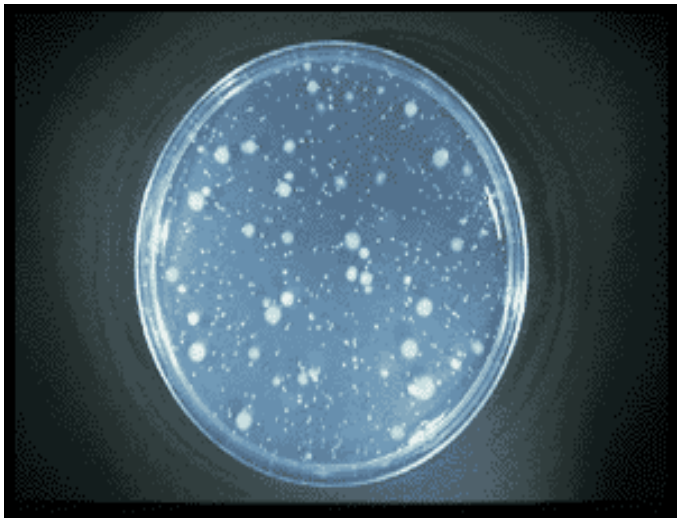


Street vending site

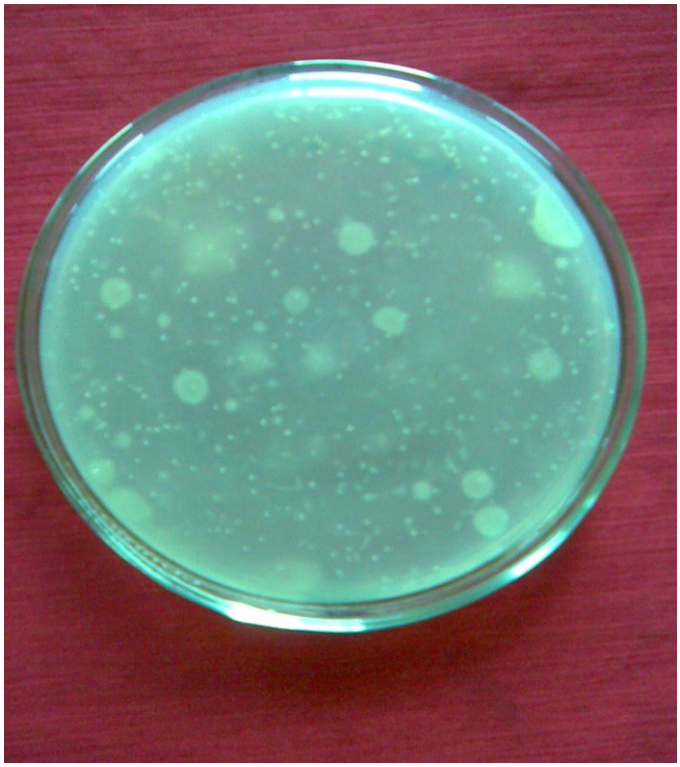


Restaurant

Plate. 2. Bacterial growth in grape juice collected from street vending site and restaurant

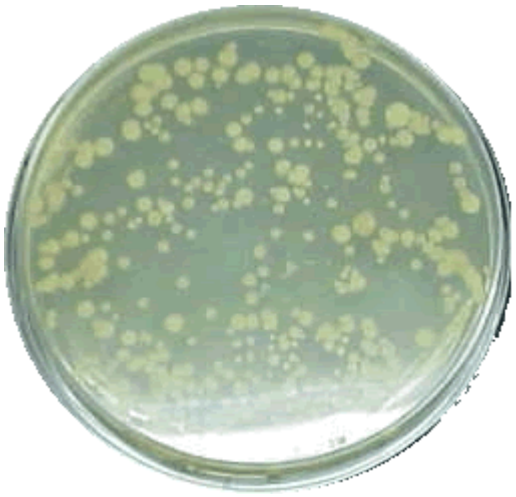


Street vending site

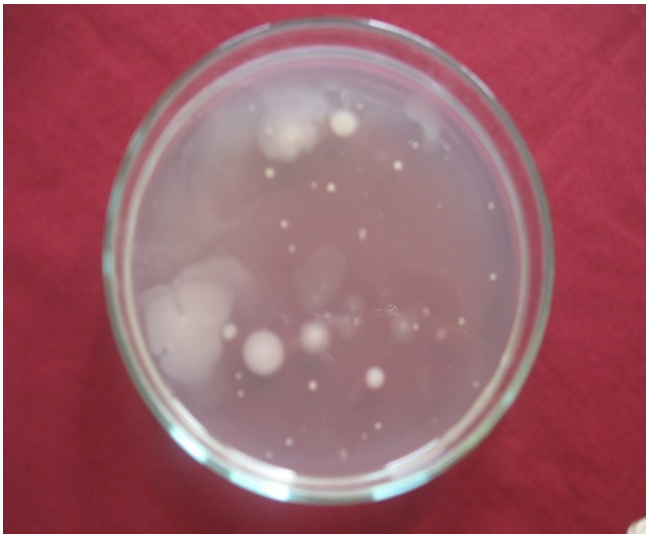


Restaurant

Plate.3. Bacterial growth in lime juice collected from street vending site and restaurant



Street vending site



Restaurant

Table 45 – Bacterial count ($x10^6$cfu ml^{-1}) of fruit juices collected from restaurants

Restaurants	Pineapple juice	Grape juice	Lime juice
R1	64.00 [c]	74.67 [a]	54.00 [ab]
R2	56.67 [c]	54.33 [b]	39.33 [b]
R3	96.00 [a]	31.00 [c]	67.67 [a]
R4	77.67 [b]	55.67 [b]	43.67 [b]
Mean	73.58	53.91	51.16

Figures with even superscripts form one homogenous group

The mean bacterial count of pineapple juice, grape juice and lime juice collected from the street vending sites was $141.05x10^6$, $76.05x10^6$ and $77.22x10^6$ cfu per ml respectively whereas in restaurants it was $73.58x10^6$ cfu per ml (pineapple juice), $53.91x10^6$ cfu per ml (grape juice) and $51.16x10^6$ cfu per ml(lime juice). Details are furnished in Table 46, Fig.11 and Plates 1 to 3.

Table 46- Comparison of the mean bacterial count of fruit juices collected from street vending sites and restaurants.

Sl.no	Juice	Bacteria ($x10^6$ cfu ml^{-1})		t value
		Street vending sites	Restaurants	
1	Pineapple	141.05	73.58	4.88***
2	Grape	76.05	53.91	2.79***
3	Lime	77.22	51.16	4.71***

*** - Significant at one per cent level

Significant variation was observed in the mean bacterial count of all the three fruit juices collected from the street vending sites and restaurants.

4.4.2.2. Yeast

The mean yeast count of pineapple, grape and lime juices collected from the street vending sites was found to be $25.27x10^4$, $30.66x10^4$ and $13.83x10^4$ cfu

per ml respectively (Table 47). The yeast count of pineapple juice which ranged from $17x10^4$ to $33.33x10^4$ cfu per ml was grouped into two sub groups where S1, S3, S5 and S6 belonged to one group and S1, S2, S4 and S6 belonged to another group after performing one way analysis of variance.

The yeast count of grape juice collected from the street vending sites ranged from $20.67x10^4$ to $39.33x10^4$ cfu per ml. In the case of grape juice also the yeast count was grouped in to two subgroups one group comprising S1, S2, S3, S5 and S6 and the other group comprising S2, S3, S4, S5 and S6. The yeast count of lime juice ranged from $10.33x10^4$ to $17x10^4$ cfu per ml and the counts were grouped in to one group.

Table 47-Yeast count ($x10^4 cfuml^{-1}$)of fruit juices collected from street vending sites

Street vending sites	Pineapple juice	Grape juice	Lime juice
S1	26.67^{ab}	39.33^{a}	17.00^{a}
S2	17.00^{b}	28.33^{ab}	11.67^{a}
S3	33.33^{a}	33.67^{ab}	12.67^{a}
S4	17.33^{b}	20.67^{b}	10.33^{a}
S5	33.33^{a}	33.67^{ab}	16.33^{a}
S6	24.00^{ab}	28.33^{ab}	15.00^{a}
Mean	25.27	30.66	13.83

Figures with even superscripts form one homogenous group

The yeast count of pineapple, grape and lime juices collected from the restaurants varied from $13.67x10^4$ to $25x10^4$, $12.67x10^4$ to $20.67x10^4$ and $6x10^4$ to $9x10^4$ cfu per ml respectively (Table 48). The mean yeast count of pineapple juice collected from the restaurants was found to be $20.16x10^4$ cfu per ml and the variation in the yeast count of pineapple juice collected from R2 was found to be significantly different from that collected from R4.

The mean yeast count of grape and lime juices was found to be $15.75x10^4$ and $7.33x10^4$ cfu per ml respectively. The variation in the yeast count of both grape and lime juices was found to be statistically insignificant as per one way analysis of variance.

Table 48 – Yeast count ($x10^4$ $cfuml^{-1}$) of fruit juices collected from restaurants

Restaurants	Pineapple juice	Grape juice	Lime juice
R1	21.67^{ab}	12.67^{a}	6.33^{a}
R2	25.00^{a}	17.00^{a}	6^{a}
R3	20.33^{ab}	20.67^{a}	9^{a}
R4	13.67^{b}	12.67^{a}	8^{a}
Mean	20.16	15.75	7.33

Figures with even superscripts form one homogenous group

Comparison of the mean yeast count of fruit juices sold by the street vendors and restaurants is shown in Table 49 and Fig.12. The mean yeast count of pineapple juice, grape juice and lime juice collected from the street vending sites was found to be $25.27x10^4$ cfu ml^{-1}, $30.66x10^4$ cfu ml^{-1} and $13.83x10^4$ cfu ml^{-1}. In the case of fruit juices collected from the restaurants the mean yeast count was found to be $20.16x10^4$(pineapple), $15.75x10^4$(grape) and $7.33x10^4$(lime) cfu per ml. Details of yeast growth in pineapple, grape and lime juices are furnished in Plates 4, 5 and 6 respectively.

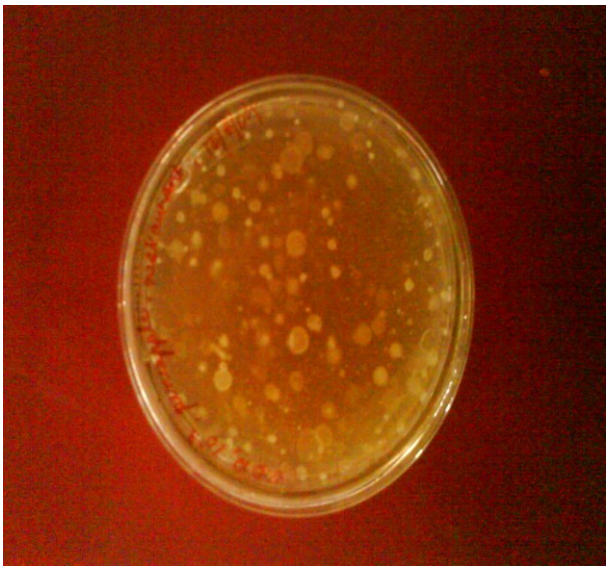
Table 49- Comparison of the mean yeast count of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Yeast ($x10^4$ cfu ml^{-1})		t value
		Street vending sites	Restaurants	
1	Pineapple	25.27	20.16	1.63^{NS}
2	Grape	30.66	15.75	5.36***
3	Lime	13.83	7.33	4.19***

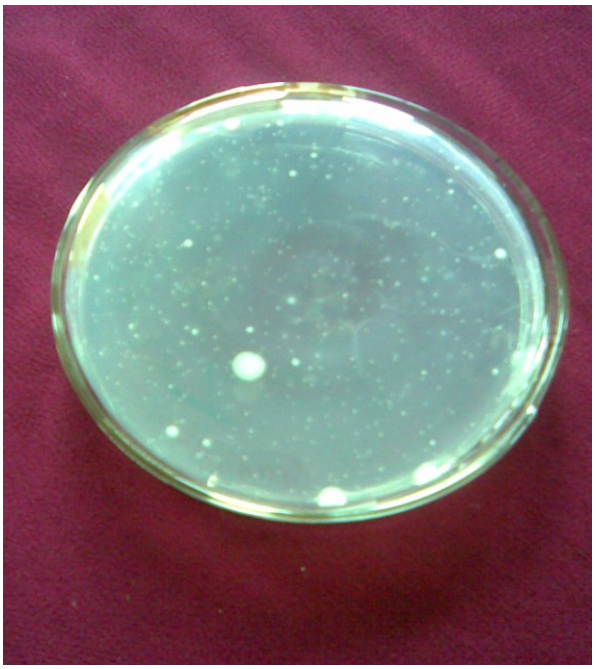
NS - Not significant

*** - Significant at one per cent level

Plate.4. Yeast growth in pineapple juice collected from street vending site and restaurant



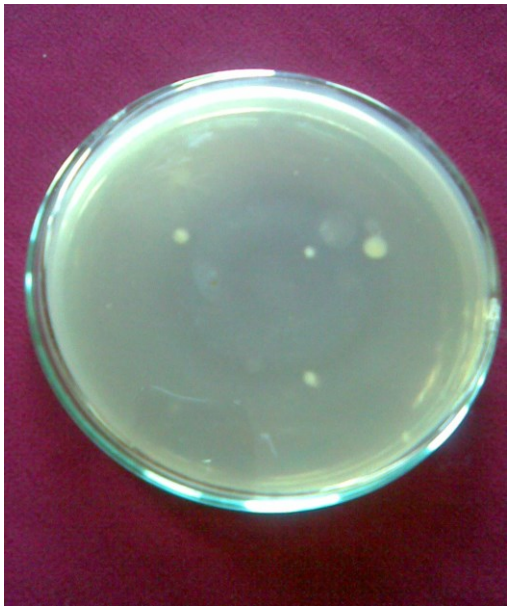
Street vending site



Restaurant

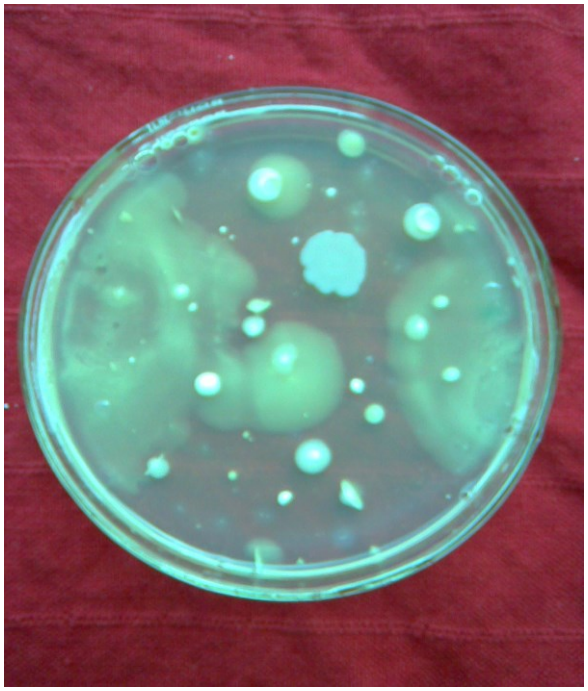
Plate.5. Yeast growth in grape juice collected from street vending site and restaurant

Street vending site

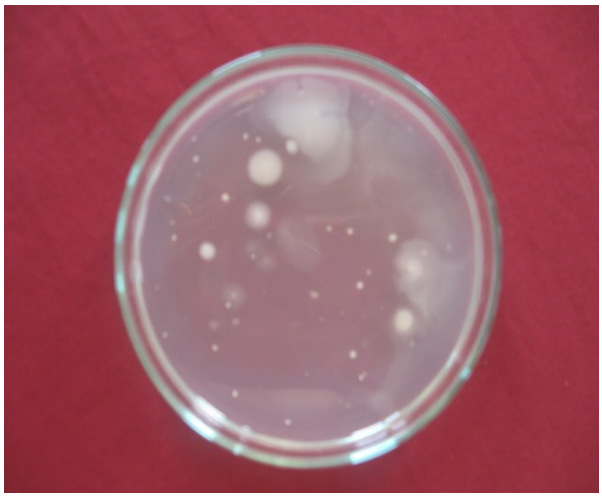


Restaurant

Plate.6. Yeast growth in lime juice collected from street vending site and restaurant



Street vending site



Restaurant

Fig.11. Comparison of the mean bacterial count of fruit juices collected from street vending sites and restaurants

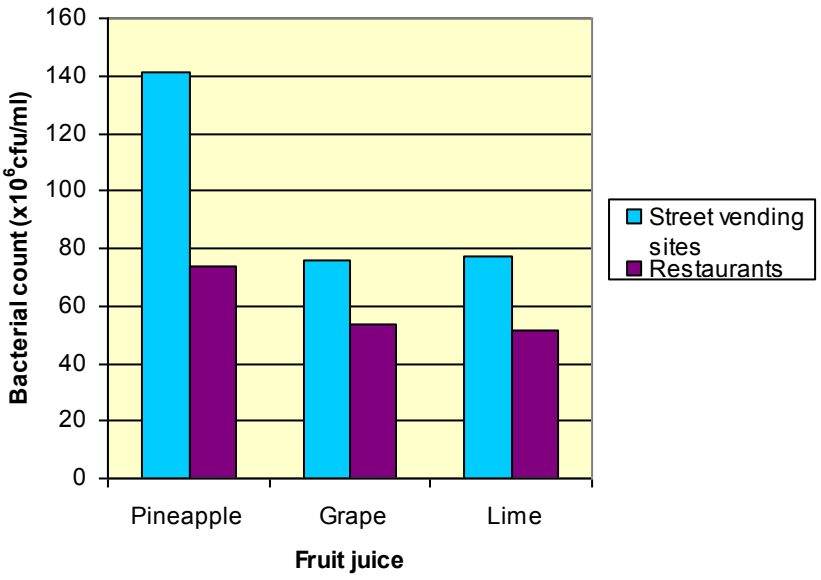
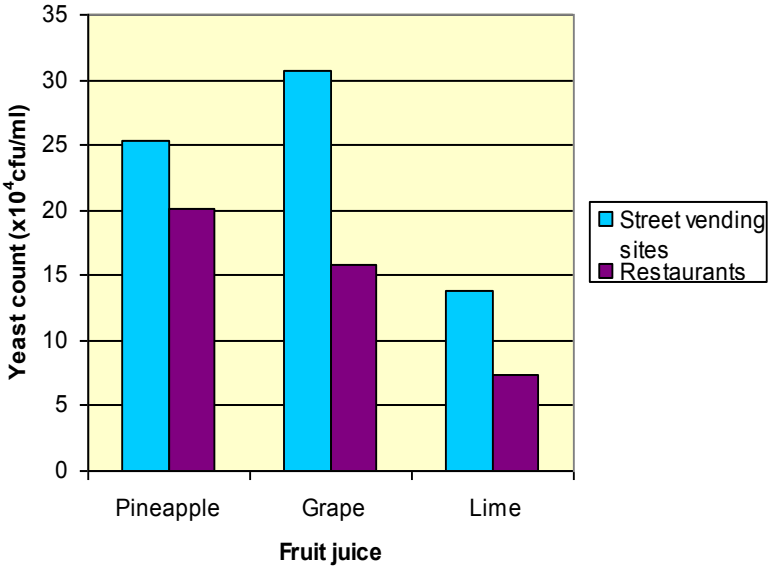


Fig.12. Comparison of the mean yeast count of fruit juices collected from street vending sites and restaurants



The variation observed in the yeast count of grape and lime juices collected from the street vending sites and restaurants was statistically significant while in the case of pineapple juice the variation in the yeast count of juices collected from the two sites was found to be statistically insignificant.

4.4.2.3. Mould

The mould count of pineapple, grape and lime juices collected from the street vending sites varied from $5.33x10^4$ to $14.33x10^4$, $4.67x10^4$ to $9.33x10^4$ and $2x10^4$ to $11x10^4$ cfu per ml with a mean count of $8.94x10^4$, $7.16x10^4$ and $7.83x10^4$ cfu per ml. The details are furnished in Table 50.

Table 50 – Mould count ($x10^4$ cfu ml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice	Grape juice	Lime juice
S1	7.66^{bc}	6.67^{a}	2.00^{b}
S2	5.33^{c}	5.33^{a}	7.67^{a}
S3	14.33^{a}	9.33^{a}	8.33^{a}
S4	6.67^{bc}	8.33^{a}	11.00^{a}
S5	2.00^{ab}	4.67^{a}	9.00^{a}
S6	7.67^{bc}	8.67^{a}	9.00^{a}
Mean	8.94	7.16	7.83

Figures with even superscripts form one homogenous group

On the basis of one way analysis of variance, the pineapple juice collected from the street vending sites was grouped into three subgroups in which first group comprises of S3 and S5, second group comprises of S1, S4, S5 and S6 and the last group comprises of S1, S2, S4 and S6.

Table 51 – Mould count ($x10^4$cfu ml^{-1}) of fruit juices collected from restaurants

Restaurants	Pineapple juice	Grape juice	Lime juice
R1	5.00^a	8.33^b	4.67^{ab}
R2	7.67^a	3.67^{bc}	6.00^a
R3	9.33^a	10.33^a	5.00^a
R4	5.67^a	2.33^c	0.67^b
Mean	6.91	6.16	4.08

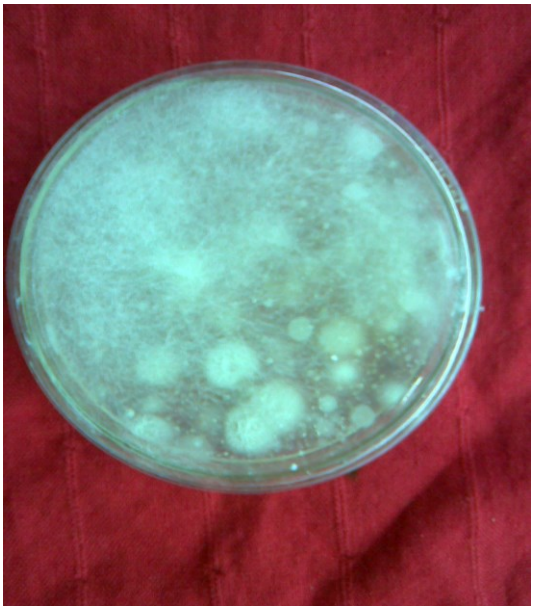
Figures with even superscripts form one homogenous group

The mean mould count of pineapple, grape and lime juices collected from the restaurants was found to be $6.91x10^4$, $6.16x10^4$ and $4.08x10^4$ cfu per ml respectively (Table 51).The mould count of pineapple juice collected from the restaurants varied from $5x10^4$ to $9.33x10^4$ cfu per ml and statistical analysis showed that the variation was statistically insignificant.

The mould count of grape juice collected from the restaurants ranged from $2.33x10^4$ to $10.33x10^4$ cfu per ml and was grouped in to three subgroups where one subgroup included only R3, second subgroup comprised of R1 and R2 and third subgroup comprised of R2 and R4. The mould count of lime juice varied from $0.67x10^4$ to $6x10^4$ cfu per ml and was grouped in to two subgroups where the first subgroup comprised of R1, R2 and R3 and second comprised of R1 and R4.

Details regarding the mean mould count of fruit juices collected from the street vendors and restaurants are furnished in Table 52 and Fig.13. The mean mould count of pineapple, grape and lime juices collected from the street vending sites was found to be $8.94x10^4$, $7.16x10^4$ and $7.83x10^4$ cfu per ml and of those collected from the restaurants was found to be $6.91x10^4$, $6.16x10^4$ and $4.03x10^4$ cfu per ml respectively. Details are furnished in Plates 7 to 9.

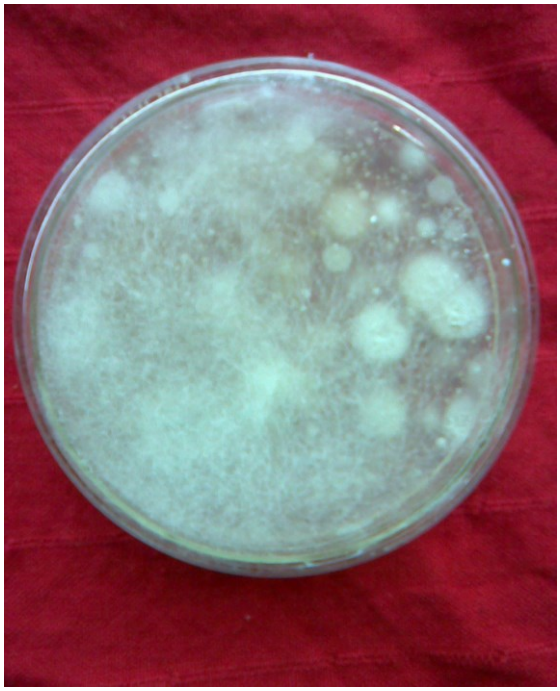
Plate.7. Mould growth in pineapple juice collected from street vending site and restaurant



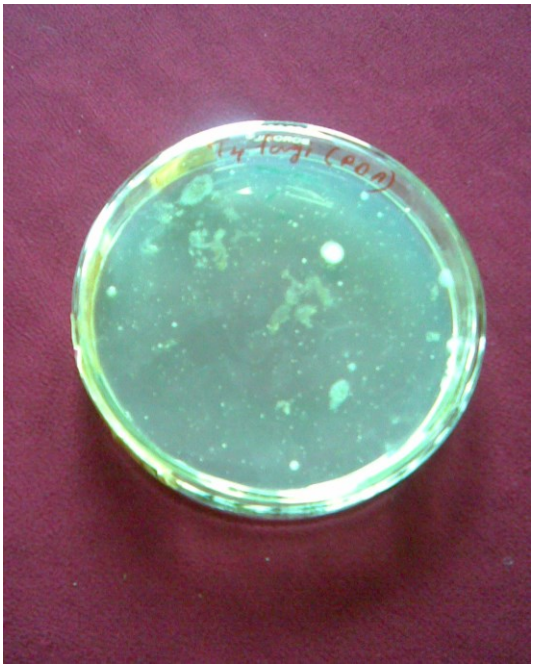
Street vending site

Restaurant

Plate.8. Mould growth in grape juice collected from street vending site and restaurant



Street vending site



Restaurant

Plate.9. Mould growth in lime juice collected from street vending site and restaurant

Street vending site

Restaurant

Table 52- Comparison of the mean mould count of fruit juices collected from street vending sites and restaurants

Sl.no	Juice	Mould ($x10^4$ cfu ml^{-1})		t value
		Street vending sites	Restaurants	
1	Pineapple	8.94	6.91	1.41^{NS}
2	Grape	7.16	6.16	0.66^{NS}
3	Lime	7.83	4.03	2.89***

NS – Not significant

*** - Significant at one per cent level

The statistical analysis showed significant variation in the mould count of lime juice collected from the two sites while for the other two juices the variation noticed in the mould count was found to be statistically insignificant.

4.4.2.4. E.coli

Mean *E.coli* count of pineapple, grape and lime juices collected from the street vending sites was found to be $7.16x10^5$, $6.05x10^5$ and $7x10^5$ cfu per ml with the highest count of $11.33x10^5$ cfu per ml in pineapple juice collected from S1 and S4, $15.67x10^5$ cfu per ml in grape juice and $13.33x10^5$ cfu per ml in lime juice collected from S1. *E.coli* was not detected in pineapple juice collected from one site (S5), grape juice collected from two sites (S4 and S5) and lime juice collected from one site (S5).

On the basis of one way analysis, the *E.coli* count of pineapple juice collected from the four street vending sites (S1, S2, S4 and S6) and one collected from S3 were grouped in to two subgroups. Similarly, the *E.coli* count of grape juice collected from the S1 and S2 and S3 and S6 was grouped in to two subgroups. In the case of *E.coli* count of lime juice collected from S1, S2, S4 and S6 was grouped into one subgroup, those juices collected from S2, S3, S4 and S6 in another subgroup and the count in juices collected from S3 and S6 in to the third subgroup.

Table 53 – *E.coli* count (x10^{5}cfu ml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice	Grape juice	Lime juice
S1	11.33^a	15.67^a	13.33^a
S2	10.67^a	11.33^a	7.67^{ab}
S3	0.66^b	4.67^b	4.00^{bc}
S4	11.33^a	0	10.33^{ab}
S5	0	0	0
S6	9.00^a	4.67^b	6.67^{abc}
Mean	7.16	6.05	7

Figures with even superscripts form one homogenous group

E.coli was detected in pineapple, grape and lime juices collected from only one restaurant (R3). The *E.coli* count was found to be 3.33x10^5, 4.67x10^5 and 3x10^5 cfu per ml in pineapple, grape and lime juices.

Table 54 – *E.coli* count (x10^5 cfu ml^{-1}) of fruit juices collected from restaurants

Restaurants	Pineapple juice	Grape juice	Lime juice
R1	0^b	0^b	0^b
R2	0^b	0^b	0^b
R3	3.33^a	4.67^a	3.00^a
R4	0^b	0^b	0^b
Mean	0.83	1.16	0.75

Figures with even superscripts form one homogenous group

The mean count of *E.coli* in pineapple, grape and lime juices collected from the street vending sites was observed to be 7.16x10^5, 6.05x10^5 and 7x10^5 cfu per ml and in those collected from the restaurants, it was found to be 0.83x10^5, 1.16x10^5 and 0.75x10^5 cfu per ml respectively. Variation observed in the *E.coli* count of fruit juices collected from the street vending sites and restaurants was

found to be statistically significant as shown in Table 55 and Fig.14. *E.coli* growth in a fruit juice collected from a street vending site is furnished in Plate.10. *E.coli* was streaked on EMB agar and is given in Plates 11a to 11c

Table 55- Comparison of the mean *E.coli* count of fruit juices collected from street vending sites and restaurant

Sl.no	Juice	*E.coli* (x10^5 cfu ml^{-1})		t values
		Street vending sites	Restaurants	
1	Pineapple	7.16	0.83	3.61***
2	Grape	6.05	1.16	2.52**
3	Lime	7	0.75	3.80***

** - Significant at five per cent level

*** - Significant at one per cent level

The *E.coli* count of water samples collected from the street vending sites varied from 9 to12x10^5 cfu ml^{-1}. The count was found to be highest in the water sample collected from S1 and lowest in the sample collected from S5.

Table 56- *E.coli* count of water samples collected from street vending sites

Street vending sites	*E.coli* (x10^5 cfu ml^{-1})
S1	12
S2	10
S3	11
S4	10
S5	9
S6	11
Mean	10.50

E.coli was observed in the water samples collected from one restaurant R3 as shown in Table 57. Mean *E.coli* count of water sample collected from the street

Plate.10. E.coli growth in fruit juice collected from street vending site

Plate.11a. E.coli streaked on EMB agar

Plate.11b. E.coli streaked on EMB agar

Plate.11c. E.coli streaked on EMB agar

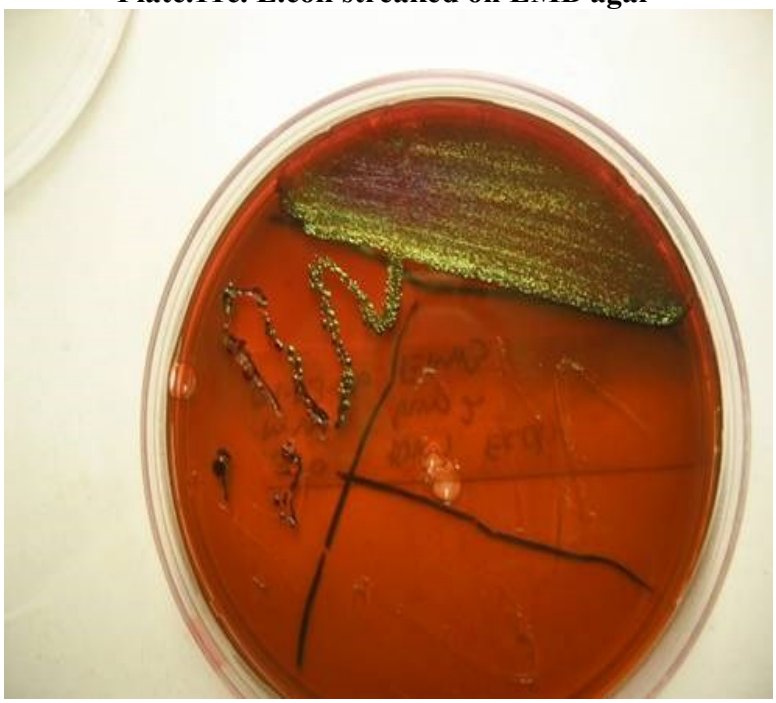


Fig.13. Comparison of the mean mould count of fruit juices collected from street vending sites and restaurants

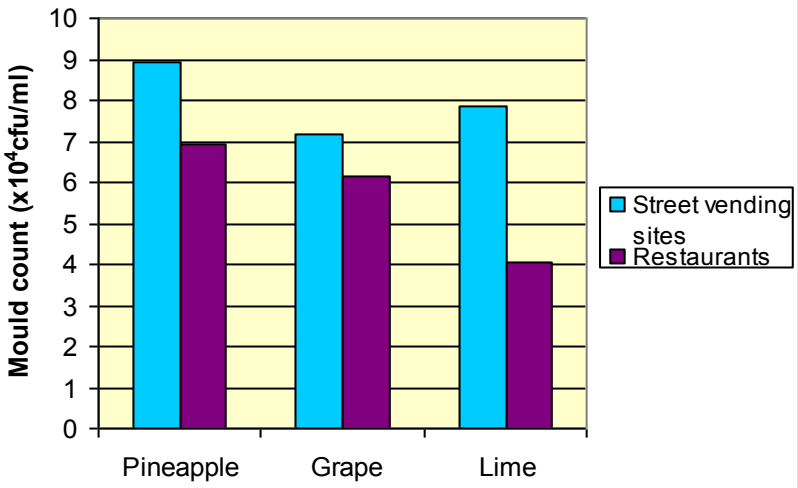
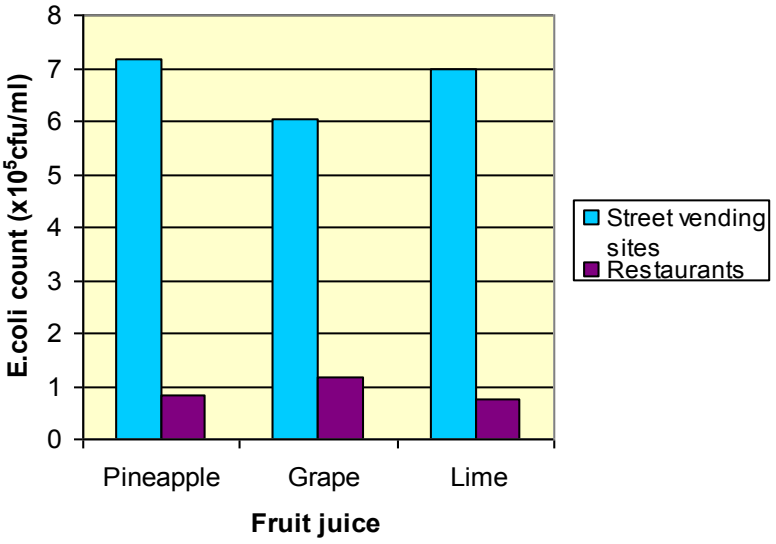


Fig.14. Comparison of the mean E.coli count of fruit juices collected from street vending sites and restaurants



vending sites was found to be higher when compared to the mean *E.coli* count of samples collected from the restaurant.

Table 57- *E.coli* count of water samples collected from restaurants

Restaurants	*E.coli* (x10^5 cfu ml^{-1})
R1	0
R2	0
R3	3
R4	0
Mean	0.75

4.4.2.5. Salmonella

Salmonella spp. was detected in pineapple (4x10^4cfu per ml), grape (3x10^4cfu per ml) and lime juices (5x10^4 cfu per ml) collected from only one street vending site (S3). Salmonella was not detected in any of the juices collected from the restaurants. Salmonella growth in pineapple, grape and lime juices collected from a street vending site is furnished in Plates12, 13 and 14 respectively.

Table 58- Salmonella count (x10^4 cfuml^{-1}) of fruit juices collected from street vending sites

Street vending sites	Pineapple juice	Grape juice	Lime juice
1	0	0	0
2	0	0	0
3	0	0	0
4	4	3	5
5	0	0	0
6	0	0	0

Plate.12. *Salmonella* growth in pineapple juice collected from street vending site

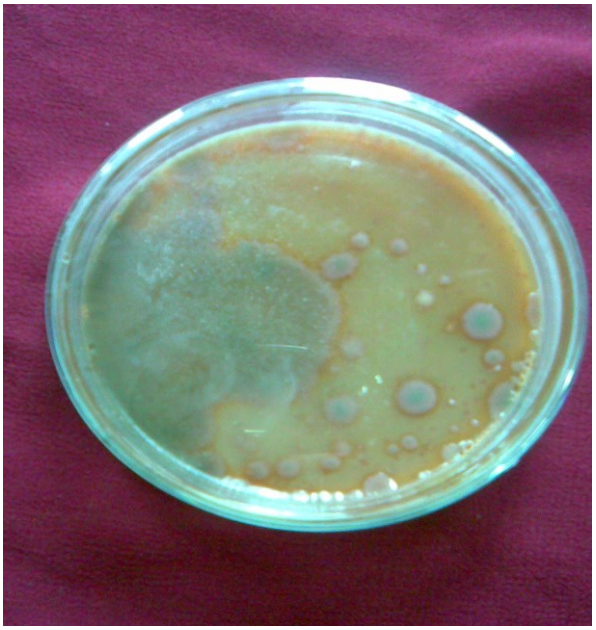
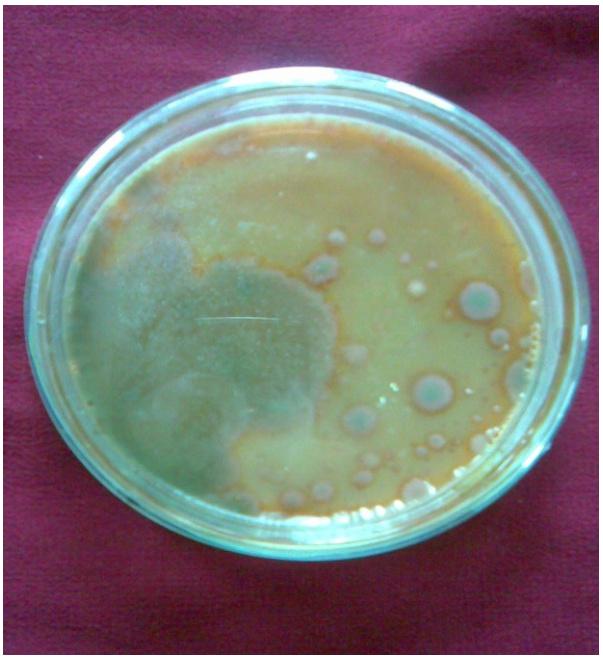


Plate.13. *Salmonella* growth in grape juice collected from street vending site

Plate.14. *Salmonella* growth in lime juice collected from street vending site



DISCUSSION

5. DISCUSSION

A critical and brief discussion of the major findings of the study is presented in this chapter. The discussion is categorized into the following broad sections.

1. General information, knowledge and practices of street vendors and restaurant workers
2. Consumption pattern of fruit juices
3. Quality of fresh fruit juices

5.1. General information, knowledge and practices of street vendors and restaurant workers

Fast foods include those ready-to-eat foods retailed by vendors on the streets and those sold in restaurants. These foods include snacks, main meals and beverages. urban street food vending and working in restaurants in cities provide employment and income for many people and also provide economic support to poor sections like small farmers as an outlet for rural produce. Precise information on the age, total monthly income, educational qualification, work experience and duration of running stall of the street vendors and restaurant workers involved in the study is essential for determining their socio-economic status.

The result of the present study on the general information of the vendors indicated that majority of the street vendors were less than 20 years of age, followed by 20-30 years and 30-40 years. In Hyderabad, Bhatt and Waghray (2000) also observed that children below 20 years involved in vending of street foods. Sheth *et al*. (2005b) indicated that among 50 street vendors of Vadodara, majority were in the age group of 20 to 40 years followed by more than 40 years and less than 20 years. The present study also indicated that 40 per cent of the restaurant workers belonged to the age category of less than 20 years followed by 30-40 years and 20-30 years. In Assam, similar findings were observed in a study conducted among restaurant workers by Biswas *et al.* (1999).

Information based on the gender of the vendors and restaurant workers in the present study indicated that all the street vendors were males. Sheth *et al*. (2005b) also indicated similar finding in their study among vendors of Vadodara. In a study conducted in Australia, Bryan (1988) observed that 80 per cent of the street vendors in Australia were males and the rest were females. Clayton *et al.* (2003) also reported that all the restaurants workers in Cameroon were males.

Income is one of the major factors influencing the socio-economic status of the vendors and restaurant workers. Street vendors are attracted to the occupation because of the possibilities of earning relatively higher income (Dawn *et al.,* 1999). The present study revealed that majority of the street vendors (85.71%) earned less than Rs.1000 from street food vending and they also earned an income of Rs.1000 per month from other jobs like foot wear repair, tailoring etc. In Calcutta, Shetty *et al.* (2001) indicated that most of the street vendors earned a monthly income of Rs.1500-4000 from street food vending. Khan and Kapoor (2002) indicated that most street vendors earned a monthly income of Rs.1000 to Rs.5000 which was observed to be above the average income of workers engaged in factories. Sheth *et al.* (2005b) indicated a monthly income of less than Rs.2000 among the vendors of Vadodara.

The present study also indicated that the restaurant workers earned an income between Rs.1000-3000 (66.67%) and more than Rs.3000 (33.33%). Most of the restaurant workers (53.33%) also earned a monthly income of Rs.1000-2000 from other jobs. In the present study it was observed that most of the street vendors and restaurant workers earned enough income from their jobs including jobs other than juice preparation to maintain a moderate socio-economic status. The result of the present study regarding the income revealed that restaurant workers earned a better income when compared to street vendors.

Literacy of the workers in hotels determines to some extent the quality of food they prepare (Biswas *et al*., 1999). Lack of education of street vendors were listed as one of the major factors contributing for the contamination of street foods (Kakar *et al.* (1998), Hussein *et al*. (2001), Mulata and Ashenafi (2001), Chandrasekhar *et al.* (2003), Ali *et al*. (2004), Muinde and Kurian (2005), Barro *et al*. (2006), Oliveira *et al*. (2006), Rajanna *et al*.(2006) and Chumber *et al*. (2007). In the present study, 94.29

per cent of the street vendors were found to be educated up to primary school level and only 5.71 per cent had attained high school education. The reason for low level of education could be the low socio-economic status of the families. Similar findings were observed by Poulos and Bhat(2000) among the vendors in Bangladesh where only six per cent were educated up to high school and the rest of the vendors were found to be illiterate. Bharathi (2002) also observed illiteracy among 46 per cent of the vendors in Hyderabad. Regarding the educational level of restaurant workers, the present study revealed that most of the workers (86.67%) attained high school education. When compared to the street vendors the educational level of the restaurant workers were found to be better.

The present study revealed that all the restaurants and majority of the street vending sites (57.14%) had secured license under the Thrissur Corporation. About 3 per cent of the street vendors did not have a license because they did not have permanent stalls and instead they had movable kiosks which did not require the license.

Eighty per cent of the street vendors involved in the study revealed that they had an experience of more than five years in street food vending. Nearly 11 per cent had an experience of 2 to 5 years and 8.57 per cent had less than two years of experience in street food vending. Bhatt and Waghray (2000) also remarked 84 per cent of street vendors in Hyderabad carried out their operations for 5 to 10 years. Similar findings were also reported by Sheth *et al*. (2005b) in Vadodara where most of the vendors had an experience of more than five years in the field of street food vending. The present study also indicated that most of the restaurant workers (86.67%) had an experience in between 2 to 5 years and the rest (13.33%) had an experience of less than two years in restaurants.

Regarding the duration of running the stall in a day, the study revealed that all the street vendors worked only for four to five hours daily in their stalls and were found to be engaged in other jobs. In restaurants, the workers worked for more than five hours in a day. Sheth *et al*. (2005b) indicated that all the street vendors of Vadodara used to run the stall for 5 to 6 hours in a day.

Poor handling of foods and unhygienic cleaning practices during food preparation can lead to entry of pathogenic microorganisms directly or by cross contamination (Adams and Moss, 1995). In the present study, it was observed that all the street vendors cleaned their stalls once daily with phenyl. Sheth *et al*. (2005b) indicated poor cleaning practices among the street vendors of Vadodara. The authors also indicated that though all the street vendors cleaned their stalls daily, only 36 per cent used soap and water to clean the stall. Among the restaurant workers in the present study, about 66.67 per cent cleaned their cooking area twice in a day and 33.33 per cent once daily with lizol and dettol. Adams and Moss (1995) also indicated that all the restaurant workers used high quality cleaning materials to clean the restaurants. All the vendors and workers surveyed in the present study used disinfectants and rodent removal techniques to keep away insects and rodents.

Most of the street vendors collected water for juice preparation from the public corporation taps and the rest collected water from nearby restaurants. All the restaurant workers also collected water from the corporation taps connected to the restaurants and stored them in plastic cans. All the street vendors and restaurant workers cleaned the containers daily by simply washing the containers with water. Nearly 85.71 per cent of the vendors stored the water in buckets and 14.29 per cent in steel cans. Sheth *et al.* (2005b) indicated that the street vendors of Vadodara collected water from their homes and most of them stored water in steel cans and few vendors stored them in plastic cans.

Both the street vendors and restaurant workers used fresh water for preparing fruit juices. Studies conducted by Adams and Moss (1995) also indicated that the restaurants workers used fresh water for cooking purposes. Sheth *et al.*(2005b) observed that majority of the street vendors in Vadodara used the leftover water for preparing various street foods.

Regarding the serving practices, it was observed that all the street vendors and restaurant workers served fruit juices prepared from pineapple, lime, grape, musambi and orange. Pomegranate juice was served only in restaurants. The present study revealed that 94.29 per cent of the street vendors and 66.67 per cent of restaurant workers served juice in glass tumblers while very few served in disposable glasses.

Similar findings were reported by Sheth *et al.* (2005b) where only 20 per cent of the street vendors used disposable and the others used china dish, steel and glass plates for serving food. Majority of the street vendors (85.71%) and all the restaurant workers (100%) served straw for drinking the juice.

The present study indicated that all the street vendors washed the glasses by simply dipping the glasses repeatedly in the same water after each use. A study done in South Africa also reported that the vendors used the same lot of water for washing dishes as well as for cleaning the area used for food preparation (Francina and Alexander, 2000). Sheth *et al*. (2005b) also indicated that majority of the street vendors washed the plates repeatedly in the same lot of water. In the present study it was seen that all the restaurant workers washed the glasses after use by dipping and rinsing the glasses in water. All the street vendors and restaurant workers washed the glasses with soap and water at the end of days work. Most of the street vendors (85.71%) and all the restaurant workers wiped the washed glasses.

It was seen that both street vendors and restaurant workers used same napkin for wiping washed utensils and glasses. Similar findings were observed by Sheth *et al*. (2005b) in their study conducted among the street vendors of Vadodara.

Both the street vendors and restaurants workers washed the clothes used for wiping glasses and utensils daily. It was also observed that the restaurant workers also used more than one cloth for wiping. Adams and Moss (1995) also reported that the restaurant workers washed the wiping cloth everyday with soap and water but in studies conducted by Enriquez *et al*. (1997) it was observed that the restaurant workers in Cameroon did not have the habit of washing the cellulose sponges and cotton dish clothes regularly and was found to be contaminated with microorganisms. Scott and Broomfield (1990) observed that street vendors of Bangkok were careless in handling utensils and used the same wiping cloth to hold onto hot vessels while cooking and to wipe utensils after cleaning.

Majority of the street vendors (57.14%) and all the restaurant workers dried the washed wiping cloth in the sun during summer season and the rest of the street vendors did it in the shade.

Regarding the environmental hygiene of the street vending stalls, the study revealed that majority of the street vendors disposed garbage into separate pits away from the stall and other vendors burned the garbage once daily. Stagnant pools and animals were not observed around the street vending stalls. Presence of flies and dust and foul smell were observed in the street vending stalls. Almost all the street vending sites had good garbage disposal facilities. Sheth *et al*. (2005b) also observed similar findings in their studies conducted among the street vendors of Vadodara where the authors observed that most of the street vendors dumped garbage away from their stalls twice daily. However, the authors observed stagnant pools around 52 per cent of the stalls with flies and dust in most of the street vending stalls. Animals around the stalls in Vadodara were also observed in very few sites. In the present study compared to the street stalls, restaurants had a better environmental hygiene. All the restaurants had good garbage disposal facilities and in very few restaurants flies in the cooking area were observed.

Personal hygiene and health care practices of the street vendors and restaurant workers in the study indicated that they washed their hands before and after preparation with soap and water and did not use separate napkin to wipe hands. Both the vendors and workers used medication during diseased condition. Similar observation was also indicated by Sheth *et al*. (2005b) in their study among street vendors of Vadodara. Most of the vendors and all the restaurant workers did not suffer from any disease recently and majority of street vendors and restaurant workers never knew whether they were vaccinated against any disease.

All the street vending sites selected for the study did not have proper toilet facilities and the vendors simply washed their hands after using the toilet. Findings regarding poor toilet facilities and improper hand washing among the street vendors were also indicated by Collins (1997) and Sheth *et al*. (2005b). Compared to street vendors, the study indicated that restaurant workers had better toilet facilities in the restaurants and had the provision of washing hands with soap and water after using the toilet. Better toilet facilities and hygienic practices of the restaurant workers were also observed in the studies conducted by Toit and Venter (2005) in Cape Peninsula.

Majority of the street vendors and all the restaurant workers were found to be neat and clean in appearance with their hair neatly combed. Both the vendors and workers used separate napkins for wiping their nose and sweat and none of them had wounds or cuts on their hands. However, the study indicated that none of the street vendors wore head gears, aprons and gloves while the restaurant workers did wear them during preparation.

Poor knowledge of food handlers in street vending sites with regard to food safety and handling of foods is what makes the food prone to contamination (Patricia *et al*., 2000). In the present study it was seen that none of the street vendors and restaurant workers were able to name a food borne disease but it was observed that they could associate food with disease. Regarding their knowledge on washing of fruits, hands and utensils, it was found that both the vendors and workers gave positive responses. Similar findings were observed by Sheth *et al*. (2005b) in their studies conducted among the vendors of Vadodara.

Regarding the washing practices of the street vendors, the present study showed that all the vendors washed their hands and fruits before juice preparation. It was also observed that all the vendors washed the knifes, cutting boards, sieve and mixie before and after preparation. Robert (1990) also observed such cleaning practices among 50 per cent of street vendors in his study. But various studies conducted by Bryan (1988), Bean and Griffith (1990.), Pekzar *et al*. (1993), Knabel (1995) and Beuchat and Ryan (1997) observed inadequate cleaning of kitchen equipments and raw food materials before preparation. Improper handling of raw and cooked foods, improper cooking practices and poor sanitation were observed in studies conducted by Kakar *et al.* (1998), Hussein *et al*. (2001), Mulata and Ashenafi (2001), Chandrasekhar *et al.* (2003), Ali *et al*. (2004), Muinde and Kurian (2005), Barro *et al*. (2006), Oliveira *et al*. (2006), Rajanna *et al*.(2006) and Chumber *et al*. (2007).

The present study revealed that the restaurant workers also washed their hands, fruits and utensils before and after preparation. Similar findings were observed in studies conducted by Jay *et al.* (1999), Klontz *et al.* (1995) and Toit and Venter (2005) among restaurant workers.

5.2. Consumption pattern of fruit juices

Consumption pattern of beverages among people are related to age, race and gender. However, fresh fruit juices are preferred more than any other type of beverages by the consumers (Richard and Maureen, 2003). In the present study, it was seen that among the consumers visiting the street vending sites to consume fruit juices, most of them consumed pineapple juice (37.14%) followed by lime (28.57%), grape (20%), musambi (11.42%) and orange juice (2.86%). Consumers who came to the restaurants preferred pineapple (36.67%) followed by lime (26.67%), grape (16.67%), musambi (13.32%) and orange juice (6.67%). Richard and Maureen (2003) reported that 80 per cent of the children visiting the restaurants preferred pineapple juice while 50 per cent of the adolescents preferred musambi juice.

With respect to the cost of the fruit juices, the cost of pineapple juice sold by the street vendors was found to be in the range of Rs.18-20 while for those sold in restaurants were found to be in the range of Rs.25-30. The cost of grape juice sold in 94.29 per cent of the street vending sites was found to be Rs.20 and the rest (5.71%) sold the juice for Rs.30 while the cost of grape juice sold in majority of the restaurants was found to be Rs.35. In the case of lime juice, majority of the street vending sites sold the juice for Rs6-8 and 14.29 per cent of the street vendors and in 13.33 per cent of the restaurants the juice was sold for Rs.10. Majority of the restaurants sold the lime juice for Rs.15. The cost of fruit juices sold in the restaurants was found to be high when compared to those sold in street vending sites. This could be due to the more quantity of juice served in the restaurants and due to other reasons like payment of rent, payment of salary to the workers and payment of tax.

Regarding the frequency of consumption of fresh fruit juices, the present study revealed that about 46 per cent of the consumers coming to street vending sites consumed fruit juices once in a month and 25.71 per cent used to consume once in a week or rarely. From restaurants, most of the consumers drank fresh fruit juices rarely, 26.67 per cent consumed once or twice in a week. The decreased frequency of consumption of fruit juices among the consumers coming to the restaurants might be due to the awareness of the unhygienic practices followed by the vendors and restaurant workers in preparing fruit juices.

The study revealed that 80 per cent of the consumers coming to the street vending sites and the restaurants consumed fresh fruit juices due to their refreshing nature while others consumed fresh fruit juices because of their taste and nutritive value. Majority of the consumers visiting the street vending sites (57.14%) and restaurants (50%) visited the same vending sites and restaurants rarely for consuming fresh fruit juice.

Fresh fruit and fruit juice consumption has a lot of health benefits. They are not only a source of refreshment but a source of powerful antioxidants (Browne, 2007). The present study revealed that majority of the consumers visiting the street stall (78.57%) and restaurants (93.33%) had good refreshing experience after consuming fresh fruit juices while very few had bitter experience like stomach upsets after fresh fruit juice consumption. The reason for the bitter experience might be due to the unhygienic practices of the vendors and restaurant workers. Various studies conducted by Bryan (1988), Bean and Griffith (1990), Pekzar *et al.* (1993), Knabel (1995) and Beuchat and Ryan (1997) also indicated inadequate cleaning of kitchen equipments and raw food materials before preparation which were identified as the reasons for various food borne infections. Koo *et al.* (1996) also reported unhygienic practices of street food vendors which led to cholera due to the consumption of contaminated street foods especially beverages.

The present study indicated that many consumers visiting the street vending sites and restaurants consumed synthetic beverages also other than fresh fruit juices. This might be due to the less time taken by the vendors to prepare synthetic beverages and their sweetness when compared to fresh fruit juices. Among the consumers who consumed synthetic beverages, 50 per cent of the consumers preferred *nannari*, 40 per cent consumed sherbet and 10 per cent consumed syruped beverages while those consuming synthetic beverages from restaurants consumed syruped beverages.

Regarding the frequency of consumption of synthetic beverages, it was seen that majority of the consumers coming to the street stalls consumed synthetic beverages very rarely and majority of those coming to the restaurants drank synthetic beverages rarely. The study also revealed that none of the consumers who consumed

synthetic beverages from restaurants had any bitter experience while 16 per cent of the consumers had bitter experience after consuming synthetic beverages from street vending sites.

Though the consumers drank synthetic beverages also from the both the street vending sites and restaurants all the consumers who came to the street vending sites and restaurants preferred fresh fruit juices compared to synthetic beverages. Similar findings were also observed in various studies conducted by Richard and Maureen (2003), Peter (2004) and Must *et al.* (2009) where the consumers preferred fresh fruit juices when compared to RTS and milk beverages sold by the vendors. Majority of consumers visiting the street vending sites and restaurants preferred fresh fruit juices because the juices are freshly prepared and the rest of the consumers preferred them because of their refreshing nature and taste.

5.3. Quality of fresh fruit juices

5.3.1. Chemical constituents of fresh fruit juices

The acidity of pineapple juice collected from the six street vending sites and four restaurants was found to be same (0.380%). For grape juice the acidity varied from 0.540 to 0.570 per cent in the juices collected from both the street vending sites and restaurants. The acidity of lime juice varied from 0.190 to 0.250 per cent in the juices collected from street vending sites and 0.190 to 0.193 per cent in juices collected from restaurants. Shanmugham (2004) in a study conducted on the chemical composition of fruit juices observed an acidity of 0.41 per cent, 0.31 per cent and0.68 per cent in pineapple, grape and lime juices respectively.

In lime juice, highest acidity of 0.250 per cent was noticed in the juices which were collected from two street vending sites. For grape juice highest acidity of 0.570 per cent was observed in the juices collected from three street vending sites and one restaurant. When the mean acidity of three fruit juices collected from street vending sites and restaurants were compared significant variation was observed only in the acidity of lime juice collected from two sites. For pineapple and grape juices the variation was found to be statistically significant.

Though the acidity of pineapple juice collected from the two sites were the same, slightly higher acidity was observed in the grape and lime juices collected from street vending sites. The variation observed in the acidity of these two juices collected from the two sites might be due to the variation in the acid content of fruits used for the preparation of juices and due to the variation in the quantity of water used for dilution.

The mean pH of three juices collected from the street vending sites varied from 2.56 in lime juice to 3.32 in pineapple juice. The pH of three fruit juices collected from the restaurants varied from 2.66 (lime) to 3.28(pineapple). The pH of lime juice was found to be low in the juices collected from street vending sites and restaurants, while it was high in the pineapple juice collected from two sites. Shanmugham (2004) indicted a pH of 3.38, 3.80 and 2.07 in pineapple, grape and lime juices respectively.

Variation in the pH of most of the juices collected from different sites was observed especially in those collected from street vending sites. The pH of grape juice collected from three restaurants was found to be same. The variation observed in the pH of the juices collected from the different sites could be due to the variation in the method of preparation adopted by the vendors and restaurant workers.

Wide variation in the TSS content of three fruit juices collected from street vending sites and restaurants was observed. Among the three fruit juices lower TSS was noticed in lime juice collected from different locations of street vending sites and restaurants when compared to grape and pineapple juices. Higher TSS was noticed in grape juice collected from almost all the sites. In a study conducted by Shanmugham (2004) also similar observations were made in which the author indicated lower TSS in lime juice and higher in grape juice. However, the TSS content noticed in the juices prepared from lime, pineapple and grape by the author was found to be lower than the TSS content observed in the present study. The higher TSS of the fruit juices selected for the present study might be due to the addition of sugar while preparing the juices.

Among the three fruit juices, TSS content of grape juice collected from five street vending sites and three restaurants was found to be same. More variation was observed in the TSS content of pineapple juice collected from different street vending sites while from restaurants the content was found to be same in the juices collected from three sites.

Though, slightly higher TSS was observed in pineapple and grape juices collected from restaurants the increase was found to be significant only in the case of pineapple juice. However, the lower mean TSS content noticed in lime juice collected from restaurants were found to be statistically significant when compared to the TSS of the lime juice collected from the street vending sites. The variation observed in the TSS content of the juices might be due to the variation in the quantity of sugar added for the preparation of juices.

The total sugar content of pineapple juice collected from the six street vending sites varied from 22.700 to 25 per cent and from four restaurants the content was found to be same (25%). For grape juice the total sugar content varied from 24.300 to 28.400 per cent in the juices collected from street vending sites and from 25 to 28.200 per cent in the juices collected from restaurants. The total sugar content of lime juice was found to be same (16.100%) in the juices collected from both street vending sites and restaurants. Shanmugham (2004) indicated a total sugar content of 10.57 per cent in pineapple juice, 3.42 per cent in lime and 13.60 per cent in grape juice. High total sugar content of all the three juices in the present study is due to the addition of extra amount of sugar while preparing fruit juices.

Much variability was not observed in the total sugar content of the fruit juices collected from different locations. When the mean total sugar content of three fruit juices collected from street vending sites and restaurants were compared significant variation was observed only in the total sugar content of pineapple juice collected from the two sites. Though, slightly higher total sugar content was noticed in the grape juice collected from street vending site the total sugar content of lime juice was found to be same.

The reducing sugar content of pineapple juice collected from different street vending sites and restaurants varied from 18.180 to 20 per cent. For grape and lime juices the reducing sugar content varied from 22 to 22.200 per cent and 10 to 12 per cent respectively. Contradictory to this finding Shanmugham (2004) indicated a reducing sugar content of 3.95 per cent, 1.02 per cent and 11.36 per cent in pineapple, lime and grape juices. However, Tejinder *et al.* (1999) indicated a reducing sugar content of 13.5 per cent in grape juice.

The reducing sugar content was found to be same in pineapple juice collected from five different street vending locations and three restaurants. For grape juice variation in the reducing sugar content was not observed in the juices collected from different locations except from one street vending site. The reducing sugar content of lime juice was also found to be same in the juices collected from four street vending sites and from all the four restaurants.

Though the mean reducing sugar content of pineapple and grape juices was slightly high which were collected from restaurants the increase was found to be significant only in the pineapple juice. The increase in the reducing sugar content noticed in lime juice collected from street vending sites was also found to be statistically significant.

The mean non-reducing sugar content of three juices collected from the street vending sites varied from 4.78 per cent in pineapple juice to 5.54 per cent in lime juice. The non-reducing sugar content of the three fruit juices collected from the restaurants varied from 5.03 (pineapple) to 6.10 per cent (lime juice). The mean non-reducing sugar content of pineapple and grape juice was found to be low which were collected from street vending sites while it was high in lime juice collected from restaurants.

Variation in the non-reducing sugar content of grape juice collected from street vending sites was observed while for pineapple juice the content was same in juices collected from three sites and for lime juice it was same for juices collected from four sites. The non-reducing sugar content of pineapple and grape juices collected from three restaurants was found to be same while the content varied for

lime juice collected from two restaurants. The variation observed in the juices collected from the different sites could be due to the variation in the sugar added to the juice during preparation.

Vitamin C content of pineapple juice collected from the six street vending sites varied from 7.500 mg to 9.330mg100ml^{-1} and from four restaurants the content varied from 7.330 to 9.700mg100ml^{-1}. Vitamin C content of grape juice varied from 5.070 to 5.400(street vending sites) and 5.031 to 5.570mg100ml^{-1} (restaurants). For lime juice the content varied from 3.170 to 3.700 and 2.500 to 3.700mg100ml^{-1} in the juices collected from street vending sites and restaurants respectively. Shanmugham (2004) indicated a slightly higher vitamin C content of 11.56 mg, 52.74 mg and 8.96mg per 100 gm in pineapple, lime and grape juices. The lower vitamin C content observed in the juices collected from the different sites might be due to the dilution made while preparing fruit juices, amount of fruit used for the juice preparation and oxidation of vitamin C while storing the cut fruits.

Among the three juices more variability in the vitamin C content was observed in the grape juice collected from different street vending sites and restaurants. The mean vitamin C content of fruit juices collected from the street vending sites varied from 3.55mg in lime juice to 8.05 mg 100ml^{-1} in pineapple juice while in the juice collected from the restaurants the content varied from 3.40 (lime) to 8.05(pineapple)mg 100ml^{-1}. The mean vitamin C content of pineapple juice collected from street vending sites and restaurants were found to be same. Though, slightly higher vitamin C content was observed in the juices collected from restaurants, the increase was found to be statistically insignificant.

β carotene content of pineapple juice collected from the street vending sites varied from 2.771 to 3.437µg100ml^{-1}. The content in grape juices collected from two street vending sites was found to be higher than the others (0.553µg100ml^{-1}) while for lime juice β carotene content was higher in juice collected from one site (1.718µg100ml^{-1}).

The β carotene content of pineapple juice collected from the restaurants was found to be 3.104µg $100ml^{-1}$ in juices collected from two sites. Variation in the β carotene content of grape and lime juices was observed in two sites.

Though slightly higher mean β carotene content was observed in pineapple and lime juices collected from the street vending sites when compared to restaurants, the increase was found to be statistically insignificant for both the juices. In the case of grape juice, mean β carotene content of the juice collected from the restaurants was found to be higher but it was statistically insignificant. The lower β carotene content observed in the juices collected from the different sites might be due to the dilution made while preparing fruit juices, amount of fruits used for the juice preparation and oxidation of β carotene while storing the cut fruits.

The sodium content of pineapple juice varied from 2 to 2.170mg$100ml^{-1}$ in the juices collected from both the street vending sites and restaurants. Lowest sodium content of 2mg$100ml^{-1}$ of pineapple juice was noticed in the juices which were collected from two street vending sites and two restaurants. For grape juice, the sodium content was noticed only in juices collected from three street vending sites which varied from 0.060 to 0.170mg$100ml^{-1}$ while sodium was not observed in grape juice collected from the four restaurants. Sodium was not present in the lime juice collected from both the street vending sites and restaurants.

When the mean sodium content of the three fruit juices collected from street vending sites and restaurants were compared, slightly higher sodium content was noticed in pineapple juice collected from the street vending site. For grape juice high sodium content was observed in the juice collected from the street vending site which was found to be significant.

Among the three juices potassium content was found to be the same for pineapple juice collected from four street vending sites and two restaurants (2mg$100ml^{-1}$). Potassium in grape juice was observed in juices collected only from two street vending sites. In the case of lime juice same potassium content was observed in juices collected from four street vending sites and three restaurants (8mg$100ml^{-1}$).

The mean potassium content of fruit juices collected from the street vending sites varied from 0.06mg in grape juice to 7.99 mg $100ml^{-1}$ in lime juice. In the juices collected from the restaurants the content was observed to be 0 for grape juice, 2.02mg in pineapple and 7.87mg $100ml^{-1}$ in lime juice. Though, only slightly high mean potassium content was observed in the grape and lime juices collected from street vending sites, the increase was found to be statistically significant.

High sodium content noticed in pineapple and grape juices and potassium content in grape and lime juices sold by the street vendors may be due to the addition of sodium and potassium salts in the juices.

Food colours were not detected in any of the fresh fruit juices collected from street vending sites and restaurants. Kowsalya and Shyny (2005) also reported the absence of artificial colours in pineapple, grape and lime juices collected from petty shops and restaurants of Malappuram district. Contradictory to this, studies conducted by Chakravarty and Canet (1995), Stoots *et al*. (1999), Kim *et al.* (2002), Rao *et al.* (2004), Ohiokpehai (2003), Rao *et al.* (2005), Sethy (2005), Nayak and Nath (2007) and Rao and Sudersan (2008) indicated the presence of banned food colours in fruit juices sold in different outlets.

5.3.2. Microbial quality of fresh fruit juices

The bacterial count of pineapple juice collected from the street vending sites and restaurants varied from $89.33x10^6$ to $204x10^6$ cfu per ml and $56.67x10^6$ to $96x10^6$ cfu per ml. Sripathy *et al.* (2002) and Kowsalya and Shyny (2005) indicated the presence of high bacterial count in pineapple juice collected from street vending stalls. Tchango *et al*. (1992) also indicated a bacterial count of $50x10^4$ cfu per ml in pineapple juice. Contradictory to this, Sharma (1995) indicated a lower bacterial count of $0.21x10^2$ cfu per ml in fresh pineapple juice collected from street outlets. A high bacterial count of $104.33x10^6$ cfu per ml and $74.67x10^6$ cfu per ml was observed in grape juice while for lime juice the count was found to be $90x10^6$ cfu per ml and $67.67x10^6$ cfu per ml in juices collected from one street vending site and restaurant. Kowsalya and Shyny (2005) also indicated high bacterial count in grape and lime

juices collected from the street vendors while Sharma (1995) indicated zero total viable count in fresh lemon juice.

The mean bacterial count in all the fruit juices collected from the street vending sites was found to be statistically higher when compared to the count in juices collected from restaurants. This could be due to the unhygienic practices adopted by the street vendors.

The mean yeast count of pineapple, grape and lime juices collected from the street vending sites was found to be $25.27x10^4$, $30.66x10^4$ and $13.83x10^4$ cfu per ml while for the juices collected from the restaurants it was found to be $20.16x10^4$, $15.75x10^4$and $7.33x10^4$cfu per ml respectively. Though, the yeast count of all the fruit juices collected from street vending sites was higher than those collected from restaurants the increase was found to be significant only in the grape and lime juices. The decrease in the count showed the hygienic practices followed by the restaurant workers when compared to the street vendors. Boas *et al*. (2003) observed high mould and yeast counts in fresh fruit juices (pineapple, lemon, orange, sugar cane and grape) collected from street vending sites compared to the count in juices collected from restaurants because of the unhygienic practices of the vendors.

Variation was observed in the mould count of pineapple juice collected from the street vending sites and in the mould counts of grape and lime juices collected from the restaurants. Significant variation in the count of lime juice was observed only in juice collected from one street vending site. Kowsalya and Shyny (2005) indicated the presence of *Aspergillus niger* and mucor in lime and pineapple juices collected from petty shops. Nagalakshmi and Reddy (1999) also observed fungal growth in the juices which could be attributed to the inclusion of decayed parts of fruits, contaminated water and improper cleaning of the equipments and utensils.

Mean mould count of the fruit juices collected from the street vending sites was found to be $8.9x10^4$(pineapple), $7.16\ x10^4$ (grape) and $7.83\ x10^4$ (lime) cfu per ml. The mould count of pineapple, grape and lime juices collected from the restaurants was found to be $6.91\ x10^4$, $6.16\ x10^4$ and $4.03\ x10^4$cfu per ml respectively.

Though, there is an increase in the mould count in all the juices collected from the street vending sites, the increase was found to be significant in lime juice.

The *E.coli* count varied from 0 to 11.33 $x10^5$, 0 to 15.67 $x10^5$ and 0 to 13.33 $x10^5$ cfu per ml in pineapple, grape and lime juices collected from the street vending sites. *E.coli* was not detected in any of the fruit juices collected from one street vending site. Contamination of fresh fruit juices sold by street vendors with *E.coli* was observed by Kowsalya and Shyny (2005), Rao *et al.* (2006), Rajanna *et al*. (2006) and Tambekar *et al.* (2009).

E.coli was detected in pineapple (3.33 $x10^5$ cfu per ml), grape (4.67 $x10^5$ cfu per ml) and lime (3 $x10^5$ cfu per ml) juices collected from one restaurant. Boas *et al*. (2003) and Kowsalya and Shyny (2005) also observed contamination of fruit juices with *Escherichia coli* which were collected from various restaurants.

The mean *E.coli* count of the fruit juices collected from the street vending sites varied from 6.05 to 7.16 $x10^5$ cfu per ml. The mean *E.coli* count of pineapple, grape and lime juices collected from the restaurants was found to be 0.83 $x10^5$, 1.16 $x10^5$ and 0.75 $x10^5$ cfu per ml respectively.

Significant increase in the mean *E.coli* count of all three fruit juices collected from the street vending sites was observed. High *E.coli* count in fruit juices is due to the use of water contaminated with *E.coli* in the preparation of fruit juices. *E.coli* was also observed in almost all the water samples collected from different street vending sites. The mean *E.coli* count of water samples collected from the street vending sites was high when compared to the mean count of water samples collected from the restaurant.

E.coli contamination in fruit juices can also be due to improper sanitation and unhygienic practices of the street vendors. Improper handling of raw and cooked foods, improper cooking practices, poor sanitation, lack of education and low income of vendors were observed as the factors contributing for the contamination of street foods especially with *faecal coliforms* by Kakar *et al.* (1998), Hussein *et al*. (2001), Mulata and Ashenafi (2001), Chandrasekhar *et al.* (2003), Ali *et al*. (2004), Muinde

and Kurian (2005), Barro *et al*. (2006), Oliveira *et al*. (2006), Rajanna *et al*.(2006) and Chumber *et al*. (2007).

Salmonella spp. was detected in all the three fruit juices collected only from one street vending site. Arumugaswamy *et al*. (1995) indicated the presence of *Salmonella spp*. namely *Salmonella blockley, Salmonella enteritidis, Salmonella chinicol, Salmonella muenchen* and *Salmonella agona* in various ready-to –eat foods sold in various street outlets. Oliveira *et al*. (2006) indicated the presence of *Salmonella enterica* in fresh sugarcane juice sold by street vendors. Fresh fruit juices like sugarcane, pineapple, watermelon , lime, sweet lemon juice, pomegranate, apple and orange juice was reported to be contaminated with Salmonella through contaminated water in studies conducted by Tchango *et al*. (1992),Boas *et al*. (2003), Rao *et al.* (2006), Rajanna *et al*. (2006) and Tambekar *et al. (*2009).

From the present study it is evident that fruit juices sold in the street vending sites are unsafe in terms of sanitary quality though they possess nutrient quality similar to the juices collected from the restaurants. However, a comparison between the juices collected from both the sites indicated that the juices sold in restaurants were superior with respect to microbial quality. Therefore, the need to educate vendors on different aspects of health and hygienic practices and the use of water purifiers is necessary. Application of stringent laws by policy enforcement authorities to improve the quality of fruit juices sold in such centers is also important.

SUMMARY

6. SUMMARY

The present study entitled "Comparative evaluation of fresh fruit juices sold by street vendors versus restaurants" was conducted to evaluate the quality attributes of fresh fruit juices sold in the street vending stalls and restaurants of Thrissur Corporation. The fresh fruit juices were evaluated for chemical constituents and their microbial quality.

Initially, thirty five street vendors and fifteen restaurant workers were selected randomly from thirty five street vending sites and fifteen restaurants belonging to five different wards of Thrissur Corporation and were interviewed to elicit their personal information. Information based on their knowledge and practices were also obtained which determines the quality of fruit juices to an extent.

Among the street vendors and restaurant workers interviewed, majority of them were below 20 years of age. Most of the street vendors earned an income less than Rs.1000 and majority of the restaurant workers earned a monthly income of Rs.1000-Rs.3000. They also earned income from other jobs like tailoring, foot wear repairing etc.

Almost all the street vendors were educated only up to primary school level while about 87 per cent of the restaurant workers had attained high school education. Eighty per cent of the street vendors had an experience of more than 5 years in street food vending while about 87 per cent of the restaurant workers had an experience of 2 to 5 years in the field of juice preparation. Most of the vendors worked for 4 to 5 hours daily while majority of the workers worked for more than 5 hours in restaurants.

Regarding their cleaning practices, all the street vendors cleaned their stalls once with phenyl while the restaurants workers cleaned the preparation area twice daily with lizol and dettol. Both the street vendors and restaurant workers used disinfectants to keep away insects and rodents.

About 74 per cent of the street vendors collected water from public corporation taps and many stored them in buckets and few in steel cans while the restaurant workers collected water from the taps available in the restaurants and stored them in plastic cans.

All the street vending sites and restaurants served juices prepared from pineapple, lime, grape, musambi and orange. Pomegranate juice was only served in restaurants. Majority of the vendors and workers used glass tumblers to serve the juice and only a few used disposable glasses. Straws were served by majority of the street vendors and all the restaurant workers to drink the juice.

The method adopted by the street vendors to wash the glasses after each use was found to be by simply dipping them in water while the restaurant workers dipped and rinsed the glasses. Most of the vendors and all the restaurant workers wiped the washed glasses. All the restaurant workers dried the wiping cloth in shade while majority of the street vendors dried the cloth in sun.

With respect to the hygienic conditions of the street vending sites and restaurants, most of the vendors and workers daily disposed the garbage in separate pits. Flies were present in most of the street vending sites and in few restaurants. Dust and foul smell was present in most of the street vending sites while it was absent in the restaurants.

Regarding the personal hygiene of the vendors and restaurant workers, all the street vendors and 73.33 per cent of the restaurant workers did not use separate napkins to wipe hands and majority of the vendors and workers did not suffer from any disease in the recent past. Most of the vendors and workers never knew whether they were vaccinated against any disease.

All the restaurants had good toilet facilities while it was not seen in the case of street vending sites.

Majority of the street vendors and restaurant workers were neat and clean in appearance with their nails cut and hair neatly combed. All the restaurant workers

used head gears and aprons while the street vendors did not use them. About 87 per cent of the restaurant workers used gloves during preparation.

With regard to the knowledge of vendors and workers, most of the vendors and workers could not name any food borne diseases but they could associate food with disease. Positive responses with respect to safety of fast food, washing of hands, fruits and equipments before and after preparation were obtained from both vendors and workers.

A survey among 70 consumers coming to the selected street vending sites and 30 consumers coming to the selected restaurants of Thrissur Corporation was conducted to know the consumption pattern of fresh fruit juices by the consumers.

Majority of the consumers coming to the street vending sites and restaurants preferred pineapple juice and gave least preference to orange juice. About 46 per cent of the consumers consumed fruit juice from street stalls once in a month while 33.33 per cent of the consumers consumed fruit juice rarely from restaurants. Majority of the consumers visiting the street vending sites and restaurants drank fruit juices because of their refreshing nature.

The fresh fruit juices sold in the restaurants were found to be a little expensive when compared to the cost of the juices sold in the street vending sites.

Many consumers visiting the street vending sites and restaurants also consumed synthetic beverages. Majority of the consumers visiting both the sites had good experience after consuming fresh fruit juices and synthetic beverages.

All the consumers visiting the street vending sites and restaurants preferred fresh fruit juices than synthetic beverages because they were freshly prepared and more refreshing.

` After conducting the consumer survey, three most frequently consumed fresh fruit juices in the street vending sites and restaurants namely pineapple, grape and lime juices were selected for the quality evaluation. Chemical constituents such as

acidity, pH, TSS, reducing sugar, total sugar, non-reducing sugar, vitamin C, β carotene, sodium and potassium were evaluated in the selected fresh fruit juices. The presence of artificial colours was also evaluated in the selected fruit juices.

The acidity of pineapple juice collected from the street vending sites and the restaurants was found to be the same with a mean acidity of 0.380 per cent. The acidity of grape juice collected from street vending sites and restaurants varied from 0.540 to 0.570 per cent with a mean acidity of 0.56 and 0.55 per cent respectively. Lime juice collected from the street vending sites had a mean acidity of 0.21 per cent and for those collected from restaurants the mean acidity was found to be 0.19 per cent.

Mean pH of pineapple, grape and lime juices collected from the street vending sites varied from 2.56 to 3.32 and those collected from restaurants varied from 2.66 to 3.28. In both cases, the highest pH was seen in pineapple juice and lowest in lime juice.

TSS of the pineapple, grape and lime juices collected from the street vending sites varied from 25.000°brix to 26.270°brix, 24.870°brix to 30.000°brix and 16.800°brix to 18°brix with a mean TSS of 25.590°brix, 29.140°brix and 17.10°brix while for those collected from the restaurants the TSS varied from 25.670°brix to 26.000°brix, 28.670°brix to 30.000°brix and 16.500°brix to 17.000°brix with a mean TSS of 25.910°brix, 29.670°brix and 16.710°brix respectively.

Statistically significant variation was observed in the mean TSS of pineapple and lime juices collected from the street vending sites and restaurants.

Highest mean total sugar content was observed in grape juice collected from the street vending sites and restaurants and it was found to be 27.58 and 26.60 per cent while the lowest was found to be in lime juice collected from both the sites which was found to be 16.10per cent. The increase in the mean total sugar content of pineapple juice collected from the restaurants (25%) when compared to those of street vending sites (23.85%) was found to be statistically significant.

The mean reducing sugar content of pineapple, grape and lime juices collected from the street vending sites was found to be 18.48, 22.16 and 10.63 per cent while for those collected from restaurants it was found to be 19.54, 22.20 and 10 per cent respectively. The variation in the mean reducing sugar content of pineapple and lime juices collected from two sites were found to be statistically significant.

The mean non-reducing sugar content of pineapple, grape and lime juices collected from the street vending sites varied from 4.78 to 5.54 per cent and for those collected from restaurants the content varied from 5.03 to 6.10 per cent respectively. Though an increase in the mean non-reducing sugar content of all the fruit juices collected from the restaurants was observed when compared to street vending sites, the increase was found to be significant only in the case of pineapple and lime juices.

Mean vitamin C content of pineapple juice collected from street vending sites and restaurants was found to be the same ($8.05 mg100ml^{-1}$). The mean vitamin C content of grape juice collected from both the sites was found to be 5.15 and $5.19 mg100ml^{-1}$ while in the case of lime juice it was found to be 3.55 and $3.40 mg100ml^{-1}$ respectively. The variation was found to be statistically insignificant.

β carotene content of pineapple, grape and lime juices collected from the street vending sites varied from 2.771 to $3.437 \mu g100ml^{-1}$, 0.221 to $0.553 \mu g100ml^{-1}$ and 1.108 to $1.718 \mu g100ml^{-1}$ with a mean β carotene content of $3.20 \mu g100ml^{-1}$, $0.43 \mu g100ml^{-1}$ and $1.48 \mu g100ml^{-1}$ while for those collected from the restaurants the β carotene content varied from 2.937 to $3.548 \mu g100ml^{-1}$, 0.276 to $0.609 \mu g100ml^{-1}$ and 1.385 to $1.496 \mu g100ml^{-1}$ with a mean β carotene content of $3.09 \mu g100ml^{-1}$, $0.49 \mu g100ml^{-1}$ and $1.45 \mu g100ml^{-1}$ respectively.

The variation in the β carotene content of the three fruit juices collected from the two sites was found to be statistically insignificant.

Mean sodium content of pineapple juice collected from street vending sites and restaurants was found to be 2.06 and 2.05 $mg100ml^{-1}$ and in the case of grape

juice it was found to be 0.055 and 0 mg100ml^{-1}. Sodium was not observed in lime juice collected from restaurants. The increase in the mean sodium content of grape juice collected from the street vending sites was found to be statistically significant.

Mean potassium content of fruit juices collected from the street vending sites was found to be 2.01, 0.06 and 7.99mg100ml^{-1} while for pineapple, grape and lime juices collected from the restaurants the content was found to be 2.02, 0 and 7.87 mg100ml^{-1} respectively. The variation in the mean potassium content of grape and lime juices collected from two sites was found to be statistically significant.

Food colours were not detected in any of the fruit juice samples collected from the street vending sites and restaurants.

The mean bacterial count of the fresh fruit juices collected from the street vending sites varied from 76.05 to 141.05x10^6 cfu ml^{-1} and for those juices collected from the restaurants the mean count varied from 51.16 to 73.58 x10^6 cfu ml^{-1}. The increase in the bacterial count of all three fruit juices collected from the street vending sites was found to be statistically significant.

Among the fruit juices collected from the street vending sites, the highest yeast count was observed in grape juice (30.66 x10^{4}cfuml^{-1}) and lowest in lime juice (13.83 x10^{4}cfuml^{-1}) while in the juices collected from restaurants, the highest count was observed in pineapple (20.16 x10^{4}cfuml^{-1}) and lowest count in lime juice(7.33 x10^{4}cfuml^{-1}). The variation in the yeast count was found to be significant in the case of grape and lime juices.

Mean mould count of pineapple, grape and lime juices collected from the street vending sites was found to be 8.94 x10^4, 7.16 x10^4 and 7.83 x10^{4}cfuml^{-1} and for the juices collected from restaurants the count was found to be 6.91 x10^4, 6.16 x10^4 and 4.08 x10^{4}cfuml^{-1} respectively. The increase in the mould count of lime juice collected from street vending site was found to be significant.

E.coli was detected in the fruit juices collected from five street vending sites and one restaurant. The mean *E.coli* count of pineapple, grape and lime juices

collected from the street vending sites was found to be 7.16 $x10^5$, 6.05 $x10^5$ and 7 $x10^5 cfuml^{-1}$ while for the juices collected from the restaurants it was found to be 0.83 $x10^5$, 1.16 $x10^5$ and 0.75 $x10^5 cfuml^{-1}$ respectively. The variation observed in the *E.coli* count of all the fruit juices collected from both the sites was found to be statistically significant.

E.coli was detected in water samples collected from almost all the street vending sites and one restaurant. The mean *E.coli* of water samples collected from the street vending sites was found to be higher (10.50 $x10^5 cfuml^{-1}$) when compared to the mean count of water samples collected from restaurants (0.75 $x10^5 cfuml^{-1}$).

Salmonella spp. was found in pineapple, grape and lime juices collected from one street vending site. *Salmonella* was not detected in the juices collected from restaurants.

The presence of high count of bacteria, yeast, mould, *E.coli* and *Salmonella* in the juices collected from the street vending sites were due to the use of *E.coli* contaminated water for the preparation of fruit juices and the unhygienic practices and poor sanitation of vendors.

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* - Originals not seen

APPENDIX

APPENDIX-I

QUESTIONNAIRE TO ELICIT INFORMATION FROM THE STREET VENDORS/ RESTAURANT WORKERS

I. General information of the vendors:-

1. Age

2. Sex

3. Educational qualification

4. Total monthly income from the vending site

5. Income from other jobs

6. Location of the stall
   Panchayat
   Ward

7. Whether having a license from the corporation Yes / No

8. Experience in running the stall

9. Duration of running the stall in a day

II. Cleaning practices and water facilities:-

10. How frequently do you clean the stall in a day?

11. Do you use any cleaning materials? Yes / No

12. If yes, specify.

13. Do you use any disinfectants to keep away ants, flies and rats? Yes / No

14. If yes, specify.

15. From where do you collect water for preparing the beverages?

16. How do you store the collected water?

17. Do you clean the containers daily before use? Yes / No

18. If yes, how do you clean them?

19. Do you change the water collected for preparation daily? Yes / No

20. If no, for how long do you store it?

III. Serving practices:-

21. What are the different types of beverages that are prepared and served?

22. What type of glasses is used for serving? Disposable/ Glass/ Steel

23. Do you wash the glasses before serving? Yes / No

24. Do you serve straws for drinking the beverage? Yes / No

25. Do you change the straws after each use? Yes / No

26. How do you wash the glasses after use? Dip / Rinse

27. Do you use any cleaning materials for washing the glasses? Yes / No

28. If yes, specify.

29. Do you wipe the glasses after wash? Yes / No

30. Do you use separate napkins for wiping utensils and glasses? Yes / No

31. How frequently do you wash the wiping cloth?

32. Do you use any cleaning materials for washing the wiping cloth? Yes / No

33. How do you dry the wiping cloth? In sun / In shade

IV. Environmental hygiene of the stall:-

34. How do you dispose the garbage?

Neighboring roads / Surroundings of the stall / Separate pits / Others

35. How frequently is the garbage disposed?

Daily once/ Daily twice/ Alternate days/ Once a week/ Others

V. Personal hygiene and Health care practices of the vendors:-

36. Do you wash hands with any cleaning materials before preparation? Yes / No

37. Do you wash hands after preparation? Yes / No

38. If yes, how do you wash? With soap and water / Simply with water / Others

39. Do you use separate napkins for wiping hands? Yes / No

40. Do you take leave and medication when sick? Yes / No

41. Have you recently suffered from any diseases? Yes / No

42. If yes, specify.

43. Have you suffered from any gastro-intestinal disease? Yes / No

44. If yes, specify the disease and the treatment undergone.

45. Have you been vaccinated against any diseases? Yes / No

46. If yes, specify.

47. Do you have good toilet facilities here? Yes / No

48. Do you have the habit of washing hands with soap and water after toilet? Yes / No

VI. Knowledge of the vendors and their washing practices of the fruits and utensils used:-

49. Can you name any food borne diseases?

50. Do you know any symptoms of food borne diseases?

51. Is fast food consumption safe? Yes / No

52. Is hand washing important before preparation? Yes / No

53. Is washing of fruits important before preparation? Yes / No

54. Do you wash the fruits before preparing the beverages? Yes / No

55. Do you wash the knives, cutting boards, mixie and sieve before preparation? Yes / No

56. Do you wash them after preparation? Yes / No

57. How do you wash them? Simply wash / With cleaning materials

VII. On the spot observation:-

Factors observed	Present	Absent
Environmental hygiene of the stall		
1. Stagnant pool around the stall / drainage		
2. Flies		
3. Dust		
4. Foul smell		
5. Garbage disposal facility		
6. Animals around the stall		
Personal hygiene and health care practices of the vendors		
7. Neat and clean appearance		
8. Nails cut and clean		
9. Head gears and aprons		
10. Hand towels used for sweat / nose		
11. Moustache		
12. Beard		
13. Hair neatly combed		
14. Wounds on hands		
15. Covering of wounds		
16. Use of gloves		

APPENDIX-II

QUESTIONNAIRE TO ELICIT INFORMATION FROM THE CONSUMERS

1. What are the types of fresh fruit beverages consumed?

2. How frequently do you consume fresh fruit beverages from the vending sites/ restaurants?

3. What is the quantity of the beverage consumed?

4. Why do you consume fruit beverages?

5. How frequently do you visit the same vendor/ restaurant?

6. What is your experience after consuming fresh fruit beverages?

7. Do you consume synthetic beverages from the vending sites?

8. If yes, specify the beverage.

9. How frequently do you consume synthetic beverages?

10. What is the quantity of synthetic beverage consumed?

11. What is your experience after consuming synthetic beverages?

12. Do you prefer fresh fruit beverages or synthetic beverages? Give reason.

COMPARATIVE EVALUATION OF FRESH FRUIT JUICES SOLD BY STREET VENDORS VERSUS RESTAURANTS

By

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ABSTRACT OF THE THESIS
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ABSTRACT

The present study on "Comparative evaluation of fresh fruit juices sold by street vendors versus restaurants" was undertaken to evaluate the quality attributes of fresh fruit juices sold in the street vending sites and restaurants with respect to chemical constituents and microbial contamination.

A survey among the street vendors and restaurant workers from selected street vending sites and restaurants belonging to five wards of the Thrissur Corporation was conducted to elicit general information of vendors and restaurant workers and information on their knowledge and practices. Most of the vendors and restaurant workers were below 20 years of age and earned an income to fulfill their basic needs. Most of the vendors were educated up to primary school level while the restaurants workers were found to be high school educated.

Better cleaning practices were observed among the restaurant workers. Good quality cleaning materials were used by the restaurant workers compared to those used by the street vendors in cleaning the preparation area. Both the vendors and workers used disinfectants to keep away insects and rodents. Better water facilities and storage of collected water were noticed among the restaurant workers.

Both the street vendors and restaurant workers used glass tumblers to serve fruit juices but unhygienic washing practices among the street vendors were observed with regard to washing of used glasses.

Hygienic conditions with good toilet facilities were noticed in the restaurants when compared to the conditions in and around the street vending sites. Flies, dust and foul smell were noticed in the street vending sites while it was not noticed in the restaurants. Garbage disposal facilities were available for both the sites but better facilities were noticed in the restaurants.

The restaurant workers were found to be neat and clean in appearance when compared to street vendors. The restaurant workers used head gears and aprons and majority used gloves during the preparation of fruit juices while the same was not noticed among the street vendors.

Positive responses with respect to their knowledge and washing practices before and after preparation were obtained from the street vendors and restaurant workers.

The trend of fruit beverage consumption was obtained after conducting a survey among the consumers visiting the selected street vending sites and restaurants of Thrissur Corporation and all the consumers preferred fresh fruit juices than synthetic beverages. Thus, three most frequently consumed fresh fruit juices namely pineapple, grape and lime juices were selected for quality evaluation.

The fresh fruit juices collected from the six street vending sites and four restaurants were analysed for chemical constituents like acidity, pH, TSS, reducing sugar, total sugar, non-reducing sugar, vitamin C, β carotene, sodium, potassium and artificial food colours. The juices were also analysed for the enumeration of microorganisms and for the presence of any pathogenic microorganisms.

The mean acidity of pineapple juice collected from the street vending sites and restaurants was found to be same. Variation in the mean acidity was observed in the grape and lime juices collected from both the sites but statistically significant variation was observed only in the case of lime juice.

An increase in the mean TSS content of pineapple and grape juices collected from the restaurants was observed compared to the mean TSS content of juices collected from the street vending sites while in the case of lime juice an increase in the mean TSS content was observed in juice collected from street vending sites.

Significant variation in the mean total sugar content was observed only in pineapple juice collected from street vending sites and restaurants. Significant variation in the mean reducing sugar content was observed in pineapple and grape juices collected from the two sites.

An increase in the mean non-reducing sugar content of all the three fruit juices collected from the restaurants was noticed when compared to the mean non-reducing sugar content of juices collected from the street vending sites.

Higher mean vitamin C content was obtained in grape and lime juices collected from the restaurants while for pineapple juice collected from both sites it was same. Significant variation in the mean β carotene content was not noticed in the three fruit juices collected from the street vending sites and restaurants.

Significant increase in the mean sodium content of grape juice collected from the street vending sites and restaurants was noticed while the mean potassium content was found to be significantly higher in grape and lime juices collected from the street vending sites when compared to the restaurants.

Artificial colouring agents were absent in the fruit juices collected from the street vending sites and restaurants.

The fresh fruit juices collected from the street vending sites and restaurants were contaminated with bacteria, yeast and mould but juices collected from the street vending sites were grossly contaminated with these organisms. The bacterial count in all the fruit juices was significantly higher which were collected from the street vending sites when compared to that of restaurants.

Yeast count of grape and lime juices collected from the street vending sites was found to be significantly high while the mould count was found to be high in lime juice collected from the street vending sites.

Pathogenic microorganisms like *E.coli* and *Salmonella spp*. were detected in the juices collected from the street vending sites. *E.coli* was noticed in juices collected from only one restaurant. *E.coli* was also detected in the water samples collected from almost all the street vending sites and one restaurant. However, *Salmonella* was not observed in the juices collected from the restaurants.

From the study it is evident that fruit juices sold in the street vending sites are unsafe in terms of microbial quality though they possess almost similar nutritional qualities to the juices collected from the restaurants.