SUITABILITY OF RED PALM OIL AND ITS BLENDS FOR CULINARY PURPOSES

By

SMITHA SREEKUMAR

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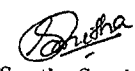

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Vellayani
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(Chairman Advisory Committee)
Assistant Professor
Department of Home Science
College of Agriculture Vellayani
Thiruvananthapuram

APPROVED BY

CHAIRPERSON

Smt Soffie Cherian,
Assistant Professor
Department of Home Science
College of Agriculture Vellayani

30 11 2001

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Associate Professor
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College of Agriculture Vellayani

30/11/01

Dr Thomas George,
Assistant Professor
Department of Soil Science and
Agricultural Chemistry
College of Agriculture Vellayani

30/11/2001

EXTERNAL EXAMINER

30/11/2001

Dr G Manimeghalai
Professor and Head
Home Science College
and Research Institute
TNAU Madurai
625 104

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Dedicated

To

My Parents

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INTRODUCTION

INTRODUCTION

Oil palm (*Elaeis guineensis*) has emerged as the second largest source of edible oil in the world In the recent years Palm oil is the most widely traded vegetable oil in the world It is used in more than ninety countries and accounts for 35 per cent of international trade in fats and oils The price of palm oil is less than other edible oils because the yield per hectare is eight times more than the yield of crops such as sunflower groundnut and soyabean (O O S J 1995) According to Amiruddin (1994) the target cultivation of oil palm in India by the year 2000 AD is 50 000 hectares Oil palm is now cultivated in 3646 hectares in Yeroor Chithara and Kulathoopuzha in Kollam district

Palm oil extracted from fresh bunches is deep red in colour due to the presence of carotenes in it and is often mentioned as red palm oil Red palm oil (R P O) is reported to be the most abundant natural source of carotenes and tocopherols Carotenes are important nutrients in the human diet and ongoing research suggests that naturally occurring palm carotenes may have important therapeutic properties Being the richest source of provitamin A RPO assumes great significance in combating vitamin A deficiency prevailing in the country and use of RPO for this purpose is the subject of recent research

Palm oil is commercially available in the form of refined bleached and deodorised (RBD) palmolein RPO is not used at present for cooking purpose though its multibenefits clearly appear to be an advantage The reddish colour

and the bland taste of RPO acts as a hindra ıce to ıts acceptab l ty Realis ng the ımportance of the nutrıents ın our daily dıet ıt ıs proposed to promote consumptıon of RPO among the public (Jayalekshmy *et al* 1996)

The quality of an edıble oıl as a cookıng med um ıs judged by vario s factors such as flavour oxıdatıve stabılıty and fatty acıd compositıon Blendıng of o ls put forward an excellent scope for prov dıng a balanced nutrıtıon source ın terms of fatty acıd compositıon as compared to pure oıls

Wıth the noble ıntentıon that cheaper cookıng med um be made avaılable to the people accordıng to their preferred taste and flavour a relatıvely new concept has been mooted by the Central Government v z blended vegetable oıls Besıdes thıs blendıng also provıdes a better opportunity to cater to the consumer s preference of desıred flavours n foodstuffs It sımultaneously offers an excellent scope for availab l ty of hıgh prıced oıls whıch are ın short supply (Saha 1995)

Blends are superıor to the unmıxed o ls ın qual ty and stabıl ty ıncludıng heat prımary and secondary oxıdatıon Some ınvestıgators have suggested that blendıng of oıls ın certaın proportıon can be promısıng ın ıncreasıng the thermal stabılıty of PUFA rıch oıls Moreover the formatıon of polymers and polar compound that corrodes the coronary track of the human body are almost reduced (Rao 1995)

Unlike many other vegetable oıls RPO has a better fatty acıd compositıon wıth a low P/S ratıo and hence the consumptıon of th s o l may not harm the user Takıng advantage of thıs qualıty RPO can be ı sed as a

major item in vegetable oil blends Such oil blends will be especially suitable for therapeutic diets

Palm oil provides a viable solution for blending with other edible oils primarily to reduce its harmful effects on the human heart (I O P J 1995)

Blending reduces the red colour of RPO and makes it appealing in its liquidity colour and flavour while ensuring a nutritionally balanced fatty acid composition (Handoo *et al* 1992)

Hence the present experiment to study the suitability of RPO and oil blends with RPO and other vegetable oils for culinary purpose is attempted

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2 1 Structure and characteristics of RPO

Palm oil is obtained from the fruit of the palm tree *Elaeis guineensis* a spec es commonly divided into 3 var eties depending on the amount of shell pulp and kernel (Jayalekshmy *et al* 1996) Dura pisifera and tenera are the three varieties of oil palm

The fruit consists of a leathery exocarp fleshy mesocarp and a hard kernel the endocarp Palm kernel oil is obtained from the endocarp (Jayalekshmy *et al* 1996) Palm oil is extracted from the mesocarp According to Ng and Tan (1998) RPO is the unrefined unbleached thick orange coloured oil extracted from the oil palm fruit with its carotenoid content intact

RPO is a highly viscous semi solid fat and is orangey red in colour NKPa *et al* (1990) observed that the iodine value and slip melting po nt of RPO may range from 45 56 and 31 38^{0}C respectively Chan (1983) reported that palm oil contains two fractions the stearin and palmolein fraction Tl e stearin fraction contains more saturated fatty acids and is solid at normal te nperatu re

Congopalm (1970) Jacobsberg (1974) Meara and Weir (1975) Gee (1984) and Goh *et al* (1985) reported that the non glyceride mater als also called unsaponifiable matter (0 5 per cent) nclude carotenoids tocopherols and phospholipids (0 2 5ppm) It also contains sterols (0 03 per cent) si cl as β sitosterol stigma sterol campesterol cholesterol (0 01 per cent) squalene

Plate 1 Red palm oil

(200-500ppm), methyl sterols (40-80ppm) and dimethyl sterols (40-80ppm) sesquiter pene and diterpene hydrocarbons (30ppm), aliphatic hydrocarbons (50ppm), aliphatic alcohols (160ppm), methyl esters (50ppm), ketones (trace) and waxes (trace).

Uragami *et al.* (1986) observed that palm oil contains both 2 - oleoyl 1, 3 dipalmitin (POP) and 2 oleoyl 1,3 distearin (SOS) which are the major components of triglycerides of cocoa butter and has a tendency to polymorphism. According to Arumughan *et al.* (1989) RPO is a complex mixture of over 99 per cent glycerides and about 0-5 per cent non-glyceride materials. The oil may also contain around 0.22 per cent moisture and impurities such as iron (4ppm) and copper (0-5ppm)

Palm oil contains a unique beneficial combination of MUFA, PUFA and SFA with around 40 per cent oleic, 10 per cent linoleic, 44 per cent palmitic and 5 per cent stearic acids (Anon, 1999).

2.2 Nutritional composition of RPO

2.2.1 Carotenoids

Ooi *et al.* (1985) indicated that among the edible oils, palm oil has the highest concentration of carotenoids of which α and β carotenes constitute about 80 per cent. Carotenoids are present in many vegetable oils, but are usually high in RPO (Tan *et al.*, 1986 and Manorama and Rukmini, 1987). According to Hassan (1987) in the refined palm oil, all the components except carotenoids are present. The carotenoids are generally removed or destroyed while refining.

According to Brubacher (1968) the carotenoid content of the oil varies depending on the degree of ripeness and the genotype of the fruit from which it is extracted

RPO is the nature's richest source of carotenoids with a concentration in the order of 700 1000 ppm (Unnithan 1996) Sundaram and Basiron (1998) reported that RPO contains a bouquet of other carotenoids such as lycopene phytoene and zeacarotenes in addition to an abundant supply of α and β carotenes

Ooi *et al* (1985) stated that palm oil is a rich source of provitamin A and can be supplemented for vitamin A deficiency diet

Brubacher (1968) observed that both alpha and beta carotene possess provitamin A activity one μ g of β carotene is equivalent to 1 66 IU of vitamin A one μ g of α carotene is equivalent to 0 9 IU of vitamin A Palm oil is therefore a rich source of vitamin A Sundaram and Basiron (1998) reported that β carotene has got more functional properties than α carotene α carotene too has got provitamin A activity but its efficacy is much lower than β carotene

Hume and Krebs (1979) stated that bioavailability of β carotene from vegetables and carrots was only a third of that of β carotene in oil They also observed that β carotene appears to be more bioavailable since RPO is a fat in which it is naturally present According to Siong (1992) carotenoids are precursors of vitamin A in the human biological system β carotene being the most active

Manorama (1992) reported that RPO s nutritionally super or to refined bleached and deodorised palm oil (RBDPO) s nce it s rich in β carotene As per her reports when it is cooked 70 80 per cent of its β carotene has been found to be retained Palm oil is commercially available in the form of refined bleached and deodorised (RBD) palmolein (O O S J 1995)

2 2 2 Tocopherols and Tocotrienols

RPO has a high content of vitamin E compared with other vegetables as reported by Shadidi (1997) Prominent cell b ologists and b ochemists such as Packer (1998) came out with positive evidence on the powerful role of vitamin E the wonder antioxidant which may well be the answer to the mankind s frantic search for the elixir of youth He found it an encourag ng coincidence that palm oil is richly endowed w th this wonder v tam n

There are two types of v tamin E viz tocopherol and tocotr enol (I O P J 1995)

Nesarethnam *et al* (1987) found that palm oil contains both tocopherols (T) as well as tocotrienols (T3) which are the unsaturated analogues of tocopherols Tan and Khor (1989) observed that palm oil is unique in that in addition to tocopherols it has high amounts of tocotrienol

Bauernfeind and Cort (1974) Jacobsberg *et al* (1978) and Gapor and Ong (1982) observed that both tocopherols and tocotrienols occur in α β γ and δ forms MacLellan (1983) reported the total tocopherol content of RPO as 800 ppm consisting of a mixture of 20 per cent α tocopherol 25 per cent α tocotrienol 45 per cent γ tocotrienol and 10 per cent δ tocotr enol

According to him they act as powerful antioxidants and help to reduce cellular damage due to free radicals that may arise from the body s normal oxidative energy metabolism Reports by O O S J (1995) indicate that of all the forms • tocopherol has the highest vitamin E activity for animals and man

2 2 3 Fatty acid composition

Palm oil s balanced composition of unsaturated and saturated fatty acids coupled with its high vitamin E content make it a naturally stable oil states Chan (1983) He further observed that palm oil cons sts of largely triglycerides which are esters of glycerol with fatty ac ds

Observations made by Tan and Flingoh (1981) shows that palm oil contains about 40 per cent each of palmitic acid and monounsaturated oleic acid with 10 per cent diunsaturated linoleic acid 5 per cent stearic ac ds like lauric myristic palmitoleic and arachid c acid Accord ng to Wong (1981) palm oil has an average free fatty acid of 3 66 per cent

The phys co chemical parameters and fatty acid composit on of crude palm oil and red palm indicated that crude palm oil has higher levels of (a) free fatty acid (b) unsaponifiable fraction and lower iodine value than RPO (Manorama and Rukmini 1989) Fatty acid composition nd cated that both have similar values of palmitic acid (42 per cent) and l nole c acid (10 per cent)

Hixson (1992) has reported that the fatty acid composit on of palm oil is very similar to the fat component of mother s milk and palm oil can therefore be used as an ingredient in some infant milk formulae

Raheja (1995) observed that the sore point raised against RPO is its high content of saturates However Zhang (1997) pointed out that monounsaturates which are good for the heart are in much greater quantity in RPO than other oils It buffers the negative aspects of SFA

2 3 Health attributes of RPO

Ninety percent of palm oil produced in the world is used for nutritional purposes (Berger and Ong 1985) RPO does not add years to one s life but certainly adds life to one s years states Raheja (1995) as the quality of life is further improved because of the beneficial effects of its minor constituents There is growing evidence that the use of palm oil not only delays the onset of diseases like cataract cancer chronic degenerative diseases of the brain but also slows down ageing and promotes better lifestyle (I O P J 1995)

2 3 1 Provitamin A activity of RPO

Vitamin A deficiency has currently been recognised as one of the most important of the three commonly occurring micronutrient deficiencies of public health significance leading to irreversible blindness in young children (Vijayaraghavan 1997) RPO is an excellent food supplement for preventing vitamin A deficiency in our population (Ghafoorunissa 1993)

Manorama *et al* (1997) reported that RPO which is a source of carotenoids in a fat medium seems to serve as an ideal vehicle by simultaneously increasing the fat as well as provitamin A intake This probably explains the high efficiency of conversion of β carotene to vitamin A The efficiency of dispersion and absorption of vitamin A and β carotene is

affected by the presence or absence of many factors among which fat in the diet is of utmost importance (Hollander 1981)

Tandon *et al* (1981) and NNMB (1991) reported that in India Bitots spots were observed in 1 5 per cent of pre school children (1 5 years) Reddy (1991) observed that RPO is one of the richest sources of carotenes and could serve as an excellent vehicle for vitamin A supplementation whicl has been reported to have beneficial effects in reducing child mortality and morbidity Vitamin A derived from natural or synthetic sources can be highly toxic when taken in overdosage Froding (1996) points that RPO β carotene can be take n in their natural state in food safely and are non toxic

The Department of Women and Child Development (Ministry of Human Resource Development) Government of India suggests unrefined red palm oil as one among the foods rich in vitamin A Tl e Helen Keller International / WHO Guidelines for prevention of blindness due to vitamin A deficiency (xerophthalmia) too recommends consumption of RPO as one among the vitamin A rich foods for prevention of vitamin A deficiency These were reported by Arumughan *et al* (1999) He also pointed out that people in the West African countries where RPO is the staple cooking medium do not suffer from vitamin A deficiency

2 3 1 1 Effects of Vitamin A supplementation trials with RPO

Studies at NIN (Manorama and Rukm ni 1992) have demonstrated that daily supplementation of about 5g of RPO improved the vitamin A status of children significantly Beaton *et al* (1993) indicated that when massive doses of vitamin A are administered once in 6 months they afford protection till tl e

next dose is given This is because of the capability of liver to store vita ni i A in the form of retinyl esters and release them as ret nol bound to prote n whe need arises

A study was conducted by Rukmini (1994) on Indian school children who were fed with supplementary snacks prepared with RPO for 60 days They had a significant increase in their serum retinol levels as well as an increased liver retinol store suggesting the ready bioavailability of β carotene Dee *et al* (1995) conducted a study to assess the efficacy of RPO for increasing retinol status of breastfed infants The study concluded that RPO incorporated in the diet of lactating mothers had the ability to enhance vitamin A status of breastfed infants

A response test was conducted by Manorama *et al* (1997) to assess vitamin A status of 24 school children who were fed for two months w th RPO incorporated into a sweet snack The snack supplied the RDA of 2400 μ g of β carotene/day Significant increase was found in serum vitamin A levels Multicentric trials in Kerala Tamil Nadu and Delhi as reported by Seshadri (1996) revealed that consumption of RPO in small quantities resulted in a significant improvement in vitamin A status of pre school children

The results of the study conducted by Manorama *et al* (1997) indicated the possibility that RPO is able to afford similar protection at the end of 6 months of non supplementation of synthet c vitam n A Anotl er study conducted by Chadha and Sharma (1997) at New Delhi revealed tl at consumption of RPO through home d ets s feasible and is effecti e i overcon ng vitamin A deficiency in the study group

2 3 2 Anticarcinogenic property

Emken (1988) Gapor *et al* (1989) Sundram *et al* (1989) and Ngah *et al* (1991) reported that tocols together with carotenoids act as antioxidants to protect tissues and membranes from free radicle damage and to prevent lung and oral cancers and the damaging effects of environmental toxins

Murakoshi *et al* (1992) reported that α carotene from palm o l has potent inhibitory effect on progression of certain types of cancers α carotene inhibited liver carcinogenesis in experimental mice It was also proved that α carotene is more effective than β carotene in inhibiting chemical induced skin tumour progression Tocotrienols have been reported to have a protective ability against carcinogenesis (Jasien *et al* 1993) Rukmini and Manorama (1993) suggested that RPO has a protective effect against mammary cancer in experimental rats Vitamin E (both tocopherol and tocotrienol der vat ves) enhanced the activity of the natural killer cells against tumour cells

As per the reports of Guthrie (1997) tocotrienols can effectively stop the multiplication of breast cancer cells He observed in a study that palm oil stripped of its vitamin E fraction promoted mammary carcinogenesis l ke other saturated fats and oils Isoprenoids a group of compou ids which include the analogues of vitamin E and β carotene suppress chemically initiated carcinogenesis (L He 1997)

Unlike many other fats and oils RPO does not enhance the y eld of chemically induced mammary tumours Studies on the growth of human breast cancer cell invitro have demonstrated that the TRF (Tocotr enol Rich Fraction) of palm oil can inhib t directly the growth of these cells

(Nesaretnam *et al* 1998) According to Raheja (1998) palm vitamin E in the form of tocotrienols has been shown to have some exemplary nutritional properties including their ability to inhibit human mammary cancer cell proliferation

2 3 3 Hypocholesterolemic property

Anderson *et al* (1976) Baudet *et al* (1984) Grundy (1986) Hornstra (1986) Hornstra (1988) Cottrell (1991) Chong Y H (1991) Krtchevsky (1991) Kritchevsky *et al* (1992) and Rukmini and Manorama (1993) found that RPO reduced blood cholesterol According to Grundy (1988) saturated fats are an important risk factor in hypercholesterolemia only when they are consumed at high levels Both RPO and RBDPO exhibited a hypocholesterol effect despite their low PUFA SFA (P S) ratios (0 24) This effect was demonstrated to be due to the presence of minor components in palm oil (Rukmini 1991)

Rukmini (1994) based on her study reported that rats fed on RPO and refined bleached and deodorised palm oil (RBDPO) had significantly lower plasma cholesterol concentrations than those fed with groundnut oil (GNO) She observed significant inhibition of micronormal 3 hydroxy 3 methyl glutaryl coenzyme A reductase activity in RPO and RBDPO groups indicating reduced synthesis of endogenous cholesterol

In palm oil fatty acids are medium chained and do not get deposited even in the adipose tissue and they are not found in chylomicrons which are the carriers of fat The high amount of MUFA and low amount of PUFA has also been considered as a factor which contribute to the hypocholesterolemic

effect (I O P J 1995) The unique combination of palm oil was reported to produce beneficial effects on the serum lipid profiles like low total cholesterol (TC) triglycerides (TG) and low dens ty lipoprotein cholesterol (HDL C) (Manorama 1992) As reported in Anon (1999) RPO do not raise the blood cholesterol levels in direct comparison with olive or canola and peanut oils

Khor and Tan (1987) reported that both the palm triglycer des and the palm oil vitamin E are important determinants for the non cholesterolemic effect of palm oil Qureshi *et al* (1991) observed that vitamin E tocotrienols in palm oil reduced circulating cholesterol in humans

Archana (1999) has reported that tocotrienol in palm oil inhibits HMG CoA reductase enzyme which is a key enzyme n the synthesis of cholesterol in the body The tocotrienols present in palm oil are known to reduce circulating cholesterol concentration in humans (Anon 1987 Hornstra and Sundaram 1987 Qureshi *et al* 1991 and Tan *et al* 1991) According to these reports this effect s attributed to a dose dependent inhibit on by tocotr enols of 3 hydroxy 3 methyl glutaryl Coenzyme A (HMG CoA) reductase thus inhibiting the invivo synthesis of cholesterol n liver a d thereby lowering serum cholesterol part cularly of the low density l poprote (Choi *et al* 1989 Heave *et al* 1990 and Ng *et al* 1991) Qureshi *et al* (1986) and Chong (1989) reported that tocotrienols inhibit HMG CoA reductase act vity significantly thereby resulting in hypercholesterolemia

2 3 4 Antioxidative effect

Tocotr enol has been reported to have a higher ant ox dant act v ty tha tocopherol (Serbinova *et al* 1991) Siong (1992) reported tl at carotenoids along with tocopherols are also powerful antioxidants wh ch have been impl cated in keeping both cancer and card ovascular d sease at bay According to Packer (1998) free radicals damage the body structures and vitamin E present in palm oil prevents formation of free radicals (oxidants)

The antioxidat ve properties of a tocotrienol enr ched fraction of palm o l were nvestigated by Kooyenga (1997) n 50 pat ents v th carot d atherosclerosis Results revealed apparent carot d atl eroscle ot c regress o e ght and progression n two of the 25 ant oxidant patients while none of the control group exhibited regress on but all 25 showed progress on Shad d (1997) reported that natural palm oil conta ns 14 different kinds of ant oxidants and all are benefic al to health

Nesaretnam *et al* (1998) observed inhibit on of smooth muscle cell prol ferat on througl alteration of protein kinase C activ ty wh ch resulted from the antioxidant properties of Vitamin E

2 3 5 Antithrombotic effect

Palm oil consumpt on resulted n a sign ficant ncrease in serun apol poprotein and a decrease in apo B demonstrat ng a favourable nfluence of d etary palm oil on th s aspect of tl e cardiovascular r sk profile (Hornstra and S ndram 1987 and Wood *et al* 1987) Rao (1994) reported tl at tl e consumpt on of palm oil as the sole source of v sible fat at n level of 0 per

cent total fat calories did not adversely influence the aggregability of whole blood or platelets

Sanders (1996) commented that palm oil was not proaggregatory Stephens (1996) reported that the daily intake of moderate doses of α tocopherol found in palm oil substantially reduced the risk of myocardial infarction As per MPOPC (1999) reports consumption of palm o l reduces blood clotting and thus prevents heart disease In a study by Sevanian (1997) it was seen that patients on a lipid lowering therapy who consumed vitamin E daily had significantly lower rates of coronary arterial lesion progression

According to NIN (1998) reports tocopherols and tocotrienols have been shown to inhibit platelet aggregation The high levels of tocopherols and tocotrienols have anti thrombotic property It has been reported by Sundaram and Basiron (1998) that rats fed on RPO have a reduced tendency for blood clotting

2 4 Food uses of palm oil

Rao *et al* (1987) and PORIM (1988) reported that palm o l lends itself to a wide range of food uses both in the domestic kitchen and n the food industry Anon (1990) reported that palm o l does not leave unpleasant room odour due to the absence of linolenic acid

2 4 1 Plastic shortenings

According to Kee (1969) palm oil is suitable for the manufacture of margarine because of its low tendency to turn rancid and therefore ensuring longer shelf life As per the reports of Tang *et al* (1983) palm oil and ts

products do contribute to softening of the consistency of vanaspati as well as to promote oil separat on

Uragami *et al* (1986) reported that paln oil can be used i ny it o with cocoa butter Kheiri (1987) found that palm oil and its products are very useful ngredients for making plastic shortenings and very large amounts of these products are used in their formulat on According to the author th s is the second largest usage of palm oil products

According to Min stry of Agriculture Forestry and Fishery (1991) the main uses of palm oil in Japan are in the production of margar ne and shortening Texturised palm oil as such or in blends is an ideal fat for short pastry and biscuits (Berger 1992) Palm oil with β carotene can help to produce margarines that are naturally coloured

2 4 2 Frying

Anon (1990) reported that palm oil is one of the best frying fats Berger (1992) stated that palm o l products have an exceptionally good life n the frying process and are therefore economical

Lin (1991) stated that for the large scale frying of potato crisps palmolein or a blend of palmole n with soya or rapeseed o l is preferied Manorama and Rukm ni (1991) observed that RPO was suitable for s ngle frying operations and preparations which involved a short heating time and completely take up the oil into the cooked product like cake uppma kh chdi and suji halwa

According to Ministry of Agriculture Forestry and Fishery (1991) n Japan palm oil s mainly used as a deep frying fat for the food manufactur ng

industry According to Berger (1991) and Wenxun and Xiaoshu (1994) palm oil with its moderate linoleic acid content very small linolenic acid content and high level of antioxidants is suitable for direct use in most frying application and this is a major use worldwide

2 4 3 Baking

According to Idris (1995) cakes prepared with palm oil in combinat on w th butter fat had better bak ng propert es than those made with pure butter fat and at the same time had the desired buttery flavour Palm oil and ts products have the tendency to crystall ze in β crystalline form and to perfoim effectively in cakes

According to Archana (1999) the flavour of cake made by subst tuting 20 per cent of butter with palm oil was well accepted and comparable to butter cake

2 4 4 Other Uses

According to Wenxun and Xiaoshu (1994) palm oil has been used for manufacturing imitation breast milk powder

According to Mori and Kaneda (1994) palm oil has melting propert es similar to butterfat and can be used in ice cream and milk product analogues

2 5 Effect of processing on RPO

2 5 1 Carotenoids

RPO l ke any other vegetable oil should be subjected to ref n ng process to remove undesirable materials such as colour pigments oxidative components gums metal contaminants and volatile compounds stated

Arumughan *et al* (1989) He also pointed out that during this ref'ning process nearly all carotenes and cons derable amounts of tocopherols aie lost

Graf (1976) reported that the colour of palm oil can be reduced to acceptable levels and good quality Wong (1977) identified some stable yellow pigments of heated palm oil wh ch are difficult to bleach and reported them to be co oxidation products of carotene and linoleate res dues

Goh *et al* (1985) observed 15 5 per cent loss of tocopherol during steam deodorization and distillation of free fatty acids in case of RPO Deodorization in the refin ng of edible oil requ res very high temperature typically 170^0C 250^0C sufficient to degrade carotenoids Onyewu *et al* (1986) studies the non volatile products of β carotene in glycerol under conditions s mulating palm oil deodorization and deep frying The highest loss of β carotene (91 per cent 97 per cent) was observed at 210^0C after 4 hours heating Okiy and Oke (1986) reported that repeated heating of red palm oil (RPO) results in oxidation of its components and fragmentation to various compounds which alter the organolept c chemical and physical propert es of oil

According to Hussain (1991) when crude palm was heated the components undergo several ox dative and thermal reaction which ult mately change the physical chemical physiochemical physiological nutritional and sensory properties of oil Manorama and Rukm ni (1991) studied the effect of different cooking methods on retension of β carotene and observed that 70 80 per cent was retained i the cooked foods On repeated he ting the autl ors noted a steep fall of carotene content w th each consecutive frying

Parvatham *et al* (1994) observed that the orange red coloured palm oil was darkened and loosed in consistency during heating According to Grut (1966) and Parvatham *et al* (1994) the free fatty acid content of both the o ls increased with the number of hours of heating

Onyewu *et al* (1986) found that even under the drastic conditions of extrusion cooking and deep frying PAH known as carcinogens were not detected above background levels in palm oil The findings therefore should allay the fears of using carotenoids in foods even when drastic process ng conditions such as high temperature and pressure are involved

2 5 2 Smoke Point

Parvatham *et al* (1994) observed that smoke po nt of RPO decreased when heated for two hours four hours and six hours Accord ng to them the decrease in smoke point of heated samples is due to an increase in concentration of free fatty acid and repeated heating

Augustin *et al* (1987) found that the decrease in smoke po nt s regarded to be primarily a consequence of the increase n acidity

According to Parvatham *et al* (1994) there was a decrease in iodine value and increase in peroxide value

2 6 Storage Characteristics of RPO

Storage of oils bring about certain changes n the r phys co chem cal constituents depending upon the type of oil and the storage condit ons l ke time temperature and the container in which the oil is being stored (Pandey 1980 and Murthi *et al* 1987) Moolayil (1983) reported that palm oil whether in crude or in processed form has excellent keeping qualit es A study

by Ukhun (1996) showed that on storage the iodine value of RPO increased with increase in water activity

Chang and Ong (1987) proved that water act vity of 0 94 at 50^0C or 0 19 per cent moisture was the deal condition for storage of RPO Rao (1994) ndicated that palm oil does not undergo much ox dat ve damage at a temperature of 180^0C unlike other vegetable oils with a h gh l noleic acid content He observed that it has certain advantages for the product on of vanaspati since it does not need hydrogenation

According to Parvatham *et al* (1995) on keeping o l made up of unsaturated fatty acids are subjected to oxidation and hydrolysis at var ous rates Jayalekshmy *et al* (1996) reported that RPO did not develop rancid odour common among unsaturated oils They also suggested that the phenolics present in palm o l also contribute to stability

According to Sarojini and Bhavani (1997) colour viscosity and refractive index of RPO as well as its blends (sunflower and groundnut) did not show any changes upon storage They pointed out that these blends can be stored for 6 months provided none of the oils possess h gh free fatty acid and peroxide value initially and conditions of storage are properly met

2 7 RPO for oil blends

Saha (1995) stated that blending of oils is the admixing of 2 or more oils having d fferent fatty acid composition According to Rao (1995) blending of palm oil with other oils may yield blends of more favourable fatty acid composition He also pointed out that blended oils may appeal to many consumers as they retain the flavour of the fam liar edible o ls

According to Hornstra (1988) and WHO (1991) the influence of high fat intake on cardio vascular status depends on the fatty acid profile and the P/S ratio (Polyunsaturated to saturated ratio)

Berger (1992) reported that for the large scale frying of potato crisps a blend of palmolein with soya or rapeseed oil is preferred to improve the surface appearance Manorama and Rukmini (1991) observed that a 1 1 blend of RPO and groundnut oil would be a good frying medium as it may not undergo many oxidative changes According to Mori and Kaneda (1994) palm oil is blended with corn oil rice bran oil and rapeseed oil to improve the heat and oxidation stability and the price competitiveness

A blend of RPO and groundnut oil at a ratio 1 1 was found to be acceptable in various snacks (Manorama 1992) According to Rao (1995) it is not difficult to devise blends of palm oil with other vegetable oils which confirms to this 1 1 1 ratio He also reported that vegetable oils derived from rapeseed groundnut and rice bran are improved by blending with palmolein

According to Saha (1995) excessive consumption of SFA will result in excessive biosynthesis of cholesterol consequently increasing the risk of coronary heart disease Gl afoorunisa (1999) advocated the combination of oils in prevention of heart diseases According to her optional intake of all the fatty acids is good in addition to maintaining PUFA/SFA ratio between 0 8 1 She also reported that combinations of sunflower palm and mustard oil in the ratio of 1 1 1 or sunflower sesame palm oil and mustard oils in the proportion of 3 1 are effective in increasing the favourable Alpha linolenic acid levels (ALNA)

According to Tyagi *et al.* (1999) blending of oils provides an answer to some extent to deterioration problem in the frying media and simultaneously offers an excellent scope for availability of high priced oils which are in short supply.

MATERIALS AND METHODS

MATERIALS AND METHODS

The 'Suitability of Red palm oil and its blends for culinary purpose' is a comprehensive study carried with an objective to formulate blends of Red palm oil (RPO) with other oils/fats and to evaluate the culinary performance of RPO and blends in selected preparations.

The methodology followed in the study is presented under the following headings

3.1 Selection of RPO for the study.

3.2 Collection of RPO

3.3 Selection of oil for blending.

3.4 Formulation of oil blends with RPO.

3.5 Selection of suitable blends.

3.6 Physical characteristics of RPO and blends.

3.7 Chemical characteristics of RPO and blends.

3.8 Suitability of RPO and its blends in different culinary preparations.

3.9 Organoleptic qualities of the products.

3.10 Storage studies of RPO and its blends.

3.11 Statistical analysis.

3.1. Selection of RPO for the study

Red palm oil is a viscous red-orange coloured oil, not commonly used for culinary purpose except in the African countries. It is unusually rich in

carotene and by far the richest natural source. Realising the importance of RPO as an edible oil in our daily diet, it is proposed to promote consumption of RPO among public (Jayalekshmi *et al.*, 1996). The limited use of unbleached RPO for culinary purpose results in untapping its potential health benefits. Hence it is important to investigate the acceptability and suitability of Red palm oil and RPO incorporated popular oil blends for culinary purpose.

3.2 Procurement of RPO

Due to lack of awareness on the nutritional and therapeutic qualities of RPO, the product has not yet conquered our markets. Oil palm processing factories at present utilise the unbleached orange red coloured palm oil mainly for research purpose. Therefore the major palm oil producing unit in Kerala, 'Oil Palm India Ltd'. was approached for the procurement of RPO for the study and 24 litres of RPO extracted at Kulathoopuzha unit was collected from their head office at Kottayam.

3.3 Selection of Oil for blending

Blending of oils can put forward an excellent scope for increasing the stability of oils and for providing balanced nutrition source in terms of fatty acid composition (Wenxun and Xiaoshu, 1994). RPO blends with other suitable edible oils could be beneficial in improving the composition in terms of polyunsaturated fatty acid (PUFA) content as well as enhancement of its acceptability. Therefore formulation of RPO blends was attempted as one of the major objectives in the study.

For the purpose of blending, cooking oils popularly used in households of Trivandrum district were identified by conducting a preliminary shop

survey. A questionnaire was formulated to collect information on cooking oils sold through retail outlets in selected markets of Thiruvananthapuram district. Details regarding the type of oil and the rank order of mobility in terms of turnover was collected from 50 shops through inventory method. The questionnaire used is given in Appendix I. Ten most popular cooking oils were selected for the formulation of RPO blends, based on the result of the survey.

3.4 Formulation of RPO blends

According to Willett (2000), the type of fat used for consumption is important from the consumer's safety point of view. Current guidelines on Human Nutrition suggests that dietary fat should be made of approximately equal amounts of saturated, monosaturated and polyunsaturated fats (I.O.P.J. 1995).

3.4.1 Saturated fatty acids (SFA)

The SFA content of each oil and the blends was assessed by computation. For this the SFA content of individual oils were obtained. The percentage of SFA in RPO and each of these oils at different ratios were calculated separately. The derived percentage was then added to obtain the SFA content of the blend of respective ratio.

3.4.2 Polyunsaturated fatty acid (PUFA)

The PUFA content of each oil and the blend was assessed by computation. For this the PUFA content of individual oils were obtained (RRL, 1997). The PUFA values of the blends of RPO with each vegetable oil at different ratios were calculated by adding the separately calculated

percentage value of PUFA in RPO and the vegetable oil in that particular blend.

3.4.3 Monounsaturated fatty acids (MUFA)

The MUFA content of each oil and blend was assessed by computation. For this the MUFA content of individual oils were obtained (RRL, 1997). The MUFA values of the blends of RPO with each vegetable oil at different ratios were calculated by adding the separately determined MUFA values of RPO and the vegetable oil in that particular blend.

3.4.4 P/S Ratio

It is the ratio of polyunsaturated fatty acid content (PUFA) to saturated fatty acid content (SFA). It was calculated using the formula :

$$\text{P/S ratio} = \frac{\%\ \text{PUFA}}{\%\ \text{SFA}}$$

The P/S ratio of all the blends at different ratios were calculated using the above formula.

Ghafoorunissa (1999) reports that optimal intake of all fatty acids is advocated in addition to maintaining the polyunsaturated (PUFA) saturated fatty acids (SFA) ratio (P/S) between 0.8 to 1. Accordingly, a number of combinations using RPO and selected cooking oils were postulated, with an intention to maintain the P/S ratio at the desired level between 0.8 to 1 in the culinary oil. The different proportions of RPO and other vegetable oils selected for blending were 9:1, 8:2, 7:3, 6:4, 5:5, 4:6 and 3:7. Combinations containing a single oil or two oils with RPO were also attempted.

Plate 2 Red palm oil and its blends


A
B
C
D
E
F

The polyunsaturated fatty acid/saturated fatty acid ratio (P/S ratio) of all the RPO incorporated blends formulated in the study were worked out by computation.

Therefore from the large number of blends formulated, ten samples that could satisfy the P/S ratio at a therapeutically acceptable level of 0.8 to 1 were chosen for the study.

However it was necessary to continue the screening to select blends that exhibit good performance with regard to its miscibility and appearance upon blending. Therefore for further screening, hedonic rating scale was administered to determine the quality attributes of such blends viz., appearance, colour, flavour and miscibility. A score card on these lines were prepared and distributed among a panel of ten selected judges to assess the quality by scoring. The score card used is presented in Appendix II. From the ten oil blends, five most acceptable RPO incorporated blends were further identified through this screening.

3.6 Physico-chemical characters of RPO/RPO blends

Red palm oil RPO is unique in its physico-chemical properties that characterise it as an edible oil.

The physical characteristics viz. specific gravity and smoke point of RPO as well as the selected blends were studied.

3.6.1 Specific gravity

It is the ratio between the density of a substance at a given temperature and the density of some substance assumed as standard. A.O.A.C method (1987) was followed for determining specific gravity.

3.6.2 Smoke point

The temperature at which decomposition of oil occurs and visible fumes are given off when oil is heated is known as smoke point. Smoke point of samples were determined by A.O.A.C. method (1987).

3.7 Chemical characteristics

The different chemical parameters studied include moisture, iodine value, saponification value and β carotene levels. The chemical analysis was done in triplicate for each parameters.

3.7.1 Moisture

Moisture content is an indirect indication of free fatty acid content of oil. Moisture content was determined by A.O.A.C. method (1987).

3.7.2 Iodine value

Iodine value is a useful indication to identify oils by determining its fat content. It is a measure of extent of unsaturated fatty acids present in fats and oils. Iodine value was estimated by A.O.A.C. method (1987).

3.7.3 Saponification value

Saponification value is related to the chain length of predominant fatty acids and is defined as the number of milligram of potassium hydroxide required to saponify one gram of fat or oil.

This was determined by the method outlined by NIN (1983).

3.7.4 β Carotene

Carotenoids are a group of lipid soluble hydrocarbon pigment molecules that are widely distributed in plant world. Carotenoids are present in traces in many vegetable oils but unusually high in RPO (Manorama and Rukmini, 1987). Hence it was important that this nutrient be analysed and the procedure outlined by C.M.O.A. (1953) was followed for its estimation.

3.8 Suitability of RPO/blends in different culinary preparations

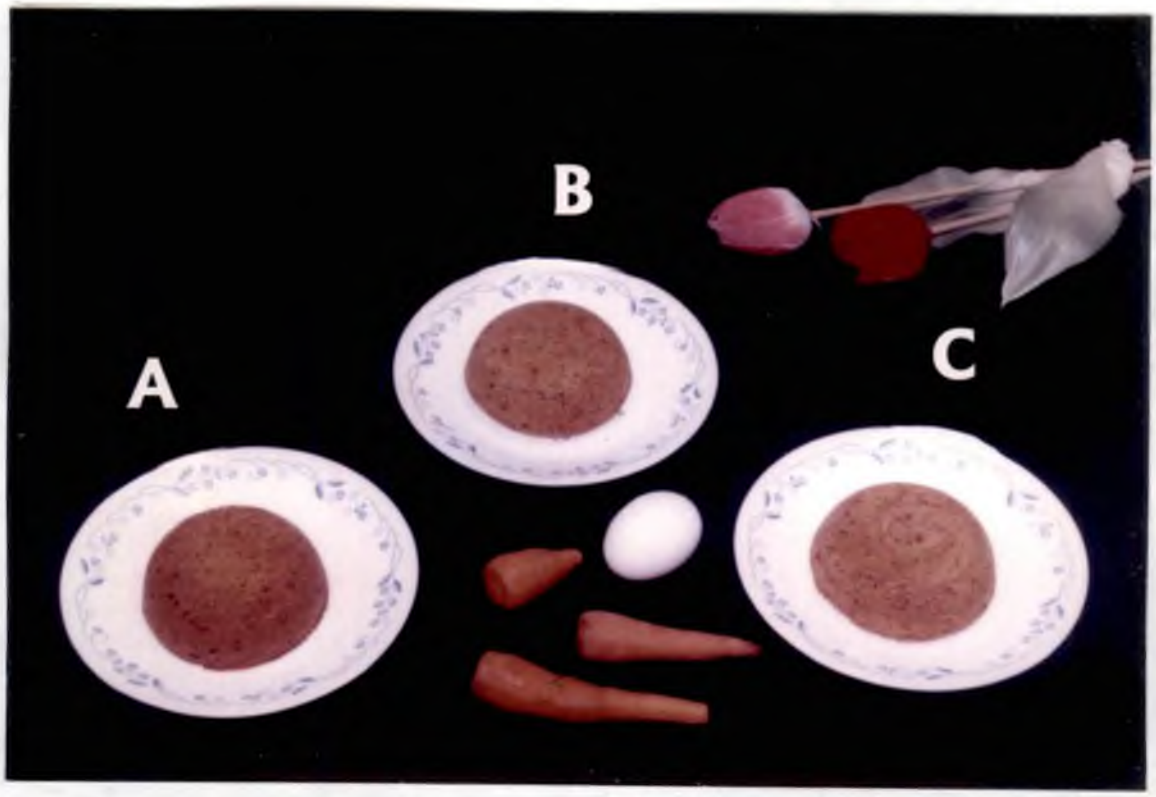
The ideal fatty acid composition and presence of carotenoids and tocopherols makes RPO a valuable dietary oil. Reports by Seshadri (1996) showed that RPO is highly acceptable and it is feasible to promote its consumption in feeding programmes as well as in household level. However it is important to consider the present status of RPO being not popular as culinary oil. Hence there is an utmost need to study its suitability and acceptability in different types of preparations.

Therefore RPO and the selected cooking oil blends incorporating RPO were tested for its performance in different products.

3.8.1 Oil incorporated as a constituent

The delicious item 'cake' was selected for this trial, where oil/fat constitutes a major ingredient in its preparation. Moreover, cake is a product that is highly appropriate to assess the culinary properties of ingredients that make up the dish.

Plate 3 Cake baked with red palm oil and its blends

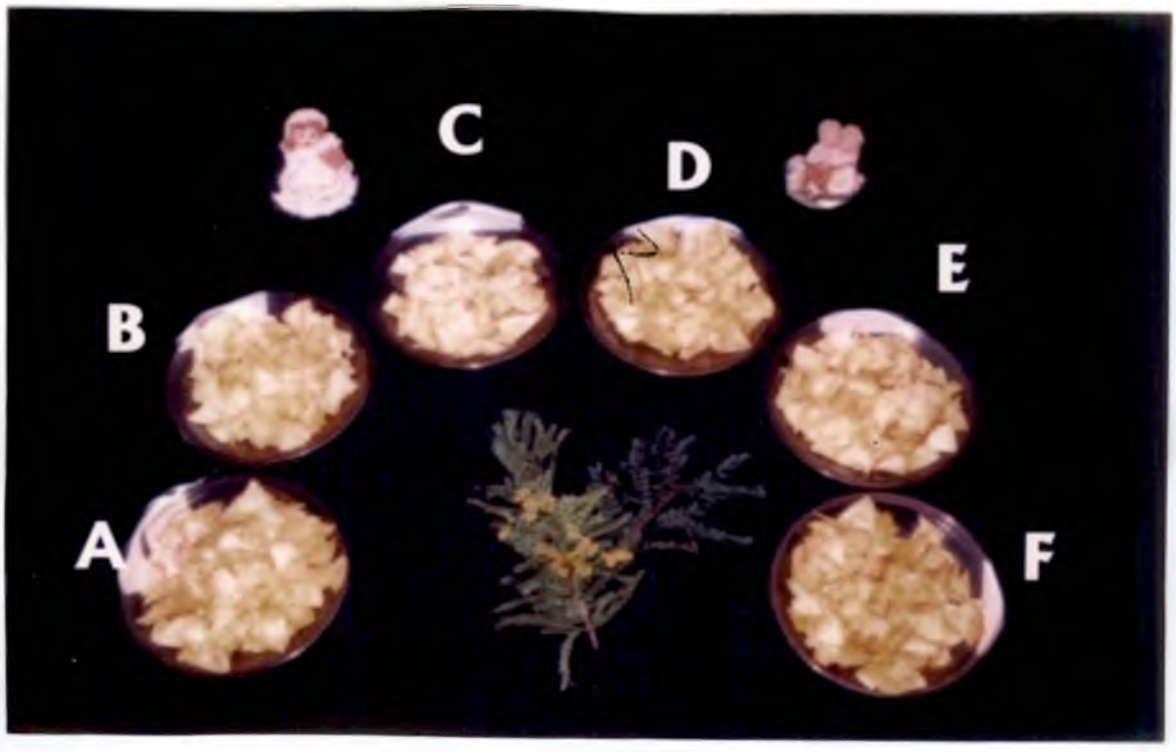

B
A
C


D
E
F

Plate 4 Potato patties fried in red palm oil and its blends

Plate 5 Tapioca chips fried in red palm oil and its blends


C
D
B
E
A
F


C
D
E
B
A
F

3 8 2 Oil forms the medium of cooking

Reports ind cate that RPO is an excellent cooking medium (Madhavi 1974) Appropriateness of RPO and ts blends as a i ediu n of cook ng was tr ed with two d fferent frying methods

a) Deep frying

In deep fat frying food is completely immersed in hot fat and therefore a large quantity s required (Raheena 1996) Attempts w th preparation of tap oca ch ps was selected for deep frying as it is a popular tem n our dietary

b) Shallow frying

In th s cook ng method only a little fat is used and the food s turned over in order that both sides may be browned (Raheena 1996) Potato patties a tasty snack prepared follow ng shallow frying method was selected n this study of culinary quality analys s of RPO and its blends

The above preparations us ng RPO and ts blends vere made tl e next day after preparation of the blends

3 9 Assessment of organoleptic qualities of products

Among the different parameters organolept c qualit es nfluence tl e consumer s appeal immediately Accord ng to Stone and Sidel (199ɔ) sensory evaluation nvolves the measurement and evaluat on of the sensory propert es of foods It s the most mportant criterion for study ng the qual ty of the product with respect to its colour flavour appearance texture and taste

The organolept c qualities of food preparations using RPO and RPO blends were evaluated by a taste panel A panel is the analytical tool in sensory evaluation The value of this tool depends on the objectivity precision and reproductability of the judgement of the panelists (Pal *et al* 1995)

The panel members were selected after initial screening through a simple triangle test as suggested by Jellinik (1985) The evaluation card for triangle test s given in appendix

From the twenty members who participated in the triangle test ten were selected as judges for the present study since a small highly sensitive panel would give more reliable than large less sensitive groups (Amerine *et al* 1965) The selected panel members were between the age of 20 25 years

The quality attributes evaluated of food products were colour appearance flavour texture taste and doneness Colour is the most important characteristic by which quality of food is judged (Aparnithi and Bindal 1995) Flavour is the unique character of odour and taste Appearance of food is the most important but it is the flavour that ultimately determines the quality and acceptability of food Jack *et al* (1995) reported that texture is a percept resulting from nteraction between food and its consumer

These qualities were evaluated on a five point scale by scoring method A suitable score card was formulated and was used for evaluating the sensory qualities of cake (Appendix IV) potato patties (Appendix V) and tapioca chips (Appendix VI)

Sensory quality test of three recipes viz cake tapioca chips and potato patties prepared using RPO and blends were carried out by taking care that the taste and flavours of one product do not influence the other

To make sure of this one item each was served to the judges on a particular day The six samples in each recipe (RPO and 5 RPO blends) were served in white plates for clear visibility Water was given in between tast ng the samples so that any aftertaste that may be carried from one sample to the other can be removed Judges were also permitted to take enough time to score the samples leisurely The testing was conducted between 3 pm and 4 pm since this is considered as the deal time for conducting sensory qual ty evaluation (Swaminathan 1974)

3 10 Storage studies of RPO and its blends

According to Murthi *et al* (1987) storage of oils bring about certa n changes in the physico chemical const tuents depending upon the type of o l and the storage conditions The storage changes in RPO and the formulated RPO blends were studied with respect to (i) physico chemical and (ii) organoleptic parameters for a period of three months A duration of three months is cons dered to be the maximum period for which generally oil s stored at the house holds RPO and the blends were homogenised and poured to plastic containers then sealed airtight Required quantity of oil in each sample for the chemical analysis and for the organoleptic assessment were stored in separate containers Similarly oil samples to be evaluated at different time intervals were also stored as separate port ons in order to facilitate easy drawing of the samples for analysis dur ng the particular nterval

3 10 1 Changes in physico chemical characteristics due to storage

RPO and the oil blends under study were stored in plastic bottles of 750 ml capacity Separate samples were kept for the analys s on each duration Analysis was carried out at intervals of fifteen days The same physico chemical parameters tested earlier on fresh oil samples were studied following the same methods applied previously

3 10 2 Changes in the organoleptic qualities on storage

Two kg of each oil sample was stored in food grade plastic containers Storage in separate conta ners were provided to facil tate systematic drawing of oil meant for each month Organolept c tests to assess the q al ty change in acceptability was carried out by preparation of products once n a month us ng the stored RPO and RPO blends selected in tl s study i e cook ng experiments using the stored oil was conducted at monthly intervals duri ng the storage period Procedures and methods followed while conducting acceptability studies with fresh RPO and RPO blends were adhered to for record ng th s data in the case of stored oil samples also

3 11 Statistical Analysis

The following statistical tools were used for the analys s of the data

3 11 1 Mean

The ar thmetic mean (X) is the quotient that results when the sum of all values in the series s d vided by the number of items It is determ ned by

$$X \quad \frac{\Sigma x}{N}$$

where X mean

x – ndıvıdual tem

N Number of ıtems

3 11 2 Analysıs of varıance

ANOVA was used for determ nıng the varıances of treatment n theır effect on the dependent varıable

RESULTS

RESULTS

The study entitled Suitability of red palm oil and its blends for culinary purposes was carried out with an objective to formulate blends of Red Palm Oil (RPO) with other oils/fats and to test the suitability of RPO and its blends in selected preparations The salient results of the study is presented under the following headings

4 1 Identification of popular cooking oils

4 2 Formulation of oil blends

4 3 Selection of suitable blends

4 4 Physico chemical characteristics of RPO and blends

4 5 Suitability of RPO and blends in culinary use

4 6 Storage studies

4 6 1 Changes in physical characteristics

4 6 2 Changes in chemical parameters

4 6 3 Changes in organoleptic qualities of products

4 1 Identification of popular cooking oils

A survey was conducted in 50 shops of Thiruvananthapuram to identify oils which are popular in the area The different oils identified are ranked according to mobility in the local markets (Table 1)

Table 1 Rank order of oils/fats based on their mobility in the local shops

Sl No	Oil	Rank order			
		1	2	3	4
1	Coconut oil	40	8	2	
2	Palm oil	10	30	5	
3	Sunflower oil		6	20	5
4	Sesame oil			15	15
5	Safflower oil		3	3	10
6	Groundnut oil			2	10
7	Mustard oil		1		4
8	Rapeseed o l			1	3
9	Soyabean oil			1	1
10	Butter		2	1	2
Total number of shops		50	50	50	50

When the sales account of oil was taken nto consideration 40 shopkeepers out of 50 ranked coconut oil as the fastest moving oil while 10 shopkeepers ranked palm oil as the best selling oil None of the shopkeepers reported similar mobility in the market for the remaining oils Among these oils sunflower oil safflower oil mustard o l and butter were found to have better mob l ty than sesame oil groundnut oil rapeseed oil and soyabean oil as revealed in Table1

4 1 1 Composition of fats and oils

Ill effects of fats and oils due to prolonged consumption are well known and these effects are said to be caused by the nature and con pos t on of fatty acids present in the oil The details pertaining to the compos tioi of common fats and o ls considered in this study are presented in Table 2

Tl e harmful const tuent ın oils vız Saturated Fatty Ac ds (SΓA) ɔ e found to be h gh coco ut o l and butter Wl le usef l co st t e ts l ke Mono Unsaturated Fatty Ac ds (MUFA) are found to be ı ɔbunda ɔce m stɔrd o l rapeseed oil gro ndn o l follo ed by sesan e o l s flowe o l (b tte soyabea o l a d cocoɔ t o l l oly U sɔ ɔted Γɔ y A ls (PUFA) wl cl plays vital rolc ɔ e ɔbol s ɔ c ol sc c l o be eg l ll i n coconut oil and butter wh le safflower oil sunflower o l soyabean o l a d sesame o l are found to be rich n them A rat o vorked out ıth Poly Unsaturated Fatty Ac ds and Saturated Fat y Ac ds otl erw se k o vn ɔs P/S rat o between 0 80 1 (Ven gopal 1999) s sa d to be a d cɔ o of tl e l eallı q alıty of a pa t cular o l P S at o of o ls vere wo ked ou ɔ l ɔ e also detailed n Table ? None of the oils are fou ɔd to ma tai l e o t ı u m at o nd catıng tl e ı portance of usı g ore tl a o ɔe o l tl e da ly d e

Table ? Γ ıtty ɔcid compos t on ɔnd P/S ı tıo of c nm n f t nd l

Sl No	Na ɔ e of tl e oil	SΓA	MUΓA	PUΓA	P S Rat o
1	Coconut o l	87 9	7 8	? ?	0 0
?	Pal o l	ɔ0 1	40 ?	9 7	1 90
ɔ	Su flowe o l	1ɔ 0	?7 0	60 0	4 6
4	Sesa e o l	1? ɔ	40 0	ɔ7 7	0?
ɔ	Safflower o l	10 0	?6 0	74 0	7 40
6	Grou dnut o l	19 0	47 0	?8 ɔ	1 48
7	M stard o l	8 0	70 0	?? 0	? 7ɔ
8	Rɔpeseed o l	8 0	70 0	?? 0	? 7ɔ
9	Soyabean o l	1?	16 0	ɔ7	4 (ɔ
10	Bu ter	ɔ? 6	?7 0	0	0 06

So ce P oceed gs of Na o al W o ksl op o Pa o ɔ d Hen l Pe spec es fo d a Reg o a Resea c L bo a o Tl u p ɔ 997

4 2 Formulation of oil blends

The ill effects of saturated fatty acids in an oil can be reduced by blending with another oil rich in PUFA resulting in a favourable fatty acid composition In order to get the favourable ratio that falls between 0 8 1 varying levels of RPO was blended with different vegetable oils

Ratio of oils included in the blends their fatty acid compositions and P/S ratio is presented in Table 3

Table 3 The fatty acid composition and P/S ratio of RPO oil blends

Sl No	Oils used	Ratio	SFA	MUFA	PUFA	P/S ratio
1	RPO Sunflower oil	60 40	35 20	10 80	30 00	0 85
2	RPO Safflower oil	65 35	36 00	35 10	31 50	0 87
3	RPO Sesame oil	40 60	27 50	40 00	26 62	0 97
4	RPO Groundnut o l	30 70	22 98	44 90	21 20	0 92
5	RPO Mustard oil	30 70	20 60	61 00	18 40	0 89
6	RPO Rapeseed oil	ɔ0 70	20 60	61 00	18 40	0 89
7	RPO Soyabean oil	60 40	34 92	30 40	28 65	0 80
8	RPO Soyabean oil Coconut oil	50 45 5	35 36	27 59	30 83	0 80
9	RPO Safflower oil Coconut oil	60 35 5	38 32	33 49	31 93	0 80
10	RPO Sunflower oil Coconut oil	50 45 5	ɔ5 67	32 54	36 82	0 90

The RPO safflower oil blend had the highest content of RPO (65 per cent) Blends incorporating sunflower o l soybean oil and a combination of safflower and coconut oil had 60 per cent RPO Combinations of soybean oil

and sunflower oil with coconut oil were blended with 50 per cent RPO while 30 per cent of RPO was used in blends with groundnut o l mustard oil and rapeseed oil

The highest P/S ratio was for the RPO sesame oil blend (0 97) followed by blends of groundnut oil (0 92) and m xture of sunflower o l and coconut oil (0 90) Blends of RPO with soybean oil combinations of soybean oil and coconut oil and safflower and coconut oil had the lowest P/S rat o (0 80) However all the blends were in the approved optimum P/S ratio between 0 8 and 1 and the blends were further screened for their organoleptic qualities

4 3 Selection of suitable blends

A five point hedonic rating scale was used for screening favourable blends The major quality attributes assessed were appearance colour flavour and miscibility

The data presented in Table 4 revealed that RPO sunflower oil blend scored the highest (17 5) followed by RPO safflower oil coconut oil (17 3) and RPO sunflower oil coconut oil (17 3) blends Scores of RPO sesame oil and RPO groundnut oil were on par (16 8) RPO safflower oil and RPO blended with soyabean oil and coconut oil scored 14 6 while RPO mustard oil had a score of 14 4 A low score of 14 0 was obtained for RPO rapeseed oil and RPO soybean oil blends

RPO sesame oil scored the h ghest in appearance (4 8) and colour (4 6) RPO sunflower oil coconut oil scored the highest n flavour (4 8) RPO sunflower oil scored the highest in miscibility (4 6)

Table 4 Acceptability levels of oil blends

Sl No	O l blends	Quality parameters (Mean Score*)				
		Appearance	Colour	Flavour	M sc b l ty	Total
1	RPO Sunflower oil	4 4	4 3	4 2	4 6	17 5
2	RPO Safflower oil Coconut oil	4 0	4 3	4 7	4 3	17 3
3	RPO Sunflower oil Coconut oil	4 0	4 0	4 8	4 5	17 3
4	RPO Sesame oil	4 8	4 7	3 0	4 3	16 8
5	RPO Groundnut oil	4 6	4 6	3 1	4 5	16 8
6	RPO Safflower oil	3 9	3 7	3 2	3 8	14 6
7	RPO Soyabean oil Coconut oil	3 8	3 6	4 0	3 2	14 6
8	RPO Mustard oil	4 0	3 8	3 0	ɔ 6	14 4
9	RPO Rapeseed oil	3 8	3 7	3 0	3 5	14 0
10	RPO Soyabean oil	3 6	3 5	3 3	3 6	14 0

* 10 panel members

Based on the total scores obtained the blends were ranked and five blends of top order detailed below were selected for further study (Table 5 and Plate 2)

Table 5 Oil blends selected for detailed study

	Oil blend	P/S RATIO	Total score	Rank
A	RPO Sunflower oil	0 85	17 5	1
B	RPO Sesame oil	0 97	16 8	4
C	RPO Groundnut oil	0 92	16 8	5
D	RPO Safflower oil Coconut oil	0 83	17 3	2
E	RPO Sunflower oil Coconut oil	0 91	17 3	3
F	RPO	0 20		

4 4 Physico chemical characteristics of RPO and blends (fresh)

The physico chemical parameters such as specific gravity smoke point moisture iodine value saponification value and β carotene content were determined in the five blends selected and also in RPO which served as control for comparison

Table 6 Physico chemical characteristics of RPO and blends

Parameters	Oil blends					RPO
	A	B	C	D	E	F
Specific gravity (g/cc)	0.923	0.925	0.917	0.916	0.923	0.925
Smoke point (^{0}C)	175.650	172.600	172.000	194.330	199.660	193.660
Moisture (per cent)	0.0506	0.0380	0.0328	0.0554	0.0429	0.0373
Iodine value (mg/100g)	85.000	81.300	75.600	80.600	85.300	54.300
Saponification value (mg/g)	180.600	186.000	172.300	186.600	194.300	185.200
β carotene (ppm)	480.600	340.300	290.000	590.600	545.000	656.600

A comparison of specific gravity of oil blends and RPO revealed that the specific gravity was found highest in F (RPO) and B (RPO and sesame oil) A (RPO and sunflower oil) E (RPO sunflower and coconut oil) D (RPO safflower and coconut oil) (RPO safflower and coconut oil) and C (RPO and groundnut oil)

Higher value for smoke point may indicate better culinary and storage quality of oil Estimation of smoke point in different blends indicates highest value for E (RPO sunflower and coconut oil) followed by D (RPO safflower and coconut oil) F (RPO) A (RPO and sunflower oil) B (RPO and sesame oil) and C (RPO and groundnut oil)

Among the different blends tested moisture content was found to be the highest in D (RPO safflower and coconut oil) followed by A (RPO and sunflower oil) E (RPO safflower oil and coconut oil) B (RPO and sesame oil) F (RPO) and C (RPO and groundnut oil)

Highest iodine value was obtained for E (RPO sunflower and coconut oil) and A (RPO and sunflower oil) followed by B (RPO and sesame oil) D

(RPO safflower oil and coconut oil) C (RPO and groundnut oil) and F (RPO) Table 6 revealed that maximum sapon fication value was for E (RPO sunflower oil and coconut oil) D (RPO safflower oil and coconut oil) B (RPO and sesame oil) F (RPO) A (RPO and sunflower oil) and the least C (RPO and groundnut oil)

Highest content of β carotene were noted in F (RPO) and D (RPO sunflower and coconut oil) followed by A (RPO and sunflower oil) E (RPO safflower oil and coconut oil) B (RPO and sesame oil) and finally C (RPO and groundnut oil)

4 5 Suitability of RPO and its blends in different culinary preparations

Suitability of RPO and its oil blends were tested by incorporat ng them in different products In product 1 viz cake (Plate 3) RPO and oil blends were incorporated as a major ingredient n the product For product 2 (Plate 4) and 3 (Plate 5) RPO and oil blends were the media of preparation Potato patties (product 2) was prepared by shallow fry ng and (product 3) tapioca chips were prepared by deep frying

These products were subjected to organolept c evaluat on The organoleptic parameters used for evaluation of acceptability of these products on a five point scale were colour appearance flavour texture taste and doneness The maximum score that could be attained for each attribute was 5 and the details are depicted in Table 7

Table 7 Organoleptic qualities of product 1 (cake)

Quality parameters	Oil samples (mean scores)					
	A	B	C	D	E	F
Colour	3 6	2 9	ɔ 2	2 9	2 8	ɔ 0
Appearance	3 6	2 8	3 0	2 8	2 9	3 0
Flavour	2 9	2 3	2 0	2 9	2 6	3 2
Texture	3 3	3 7	3 7	3 2	3 4	3 3
Taste	2 5	2 0	2 0	2 2	2 4	2 5
Doneness	3 9	3 3	3 4	3 2	3 7	3 7
Overall acceptability	19 8	17 0	17 3	17 2	17 8	18 7

Perusal of the data showed that cake in which blend A (RPO and sunflower oil 60 40) was used had the highest scores for colour (3 6) appearance (3 6) doneness (3 9) flavour (2 9) and taste (2 5)

In contrast lowest scores for appearance (2 8) was for B (RPO and sesame oil) and D (RPO safflower oil and coconut oil taste for B (RPO and sesame oil) while lowest scores for colour was assigned to E (RPO sunflower and coconut o l) and C (RPO and groundnut oil) had the lowest score for flavour

Samples in which RPO was the only oil constituent were found to have low score for taste

While taking into account the overall acceptability A (RPO and sunflower oil) had the top score (19 8) followed by F (RPO 18 7) E ((RPO sunflower and coconut oil 17 8) C (RPO and groundnut oil 17 3) D (RPO safflower oil and coconut oil 17 2) and B (RPO and sesame oil 17)

Table 8 Organoleptic qualities of product 2 (potato patties)

Quality parameters	Oil samples (mean scores)					
	A	B	C	D	E	F
Colour	3 5	3 3	3 4	3 0	3 4	3 8
Appearance	3 7	3 7	3 5	ɔ 0	3 8	3 6
Flavour	3 5	3 4	3 0	2 7	2 0	3 6
Texture	3 7	3 8	3 6	3 1	3 4	3 5
Taste	3 8	3 6	3 2	3 0	3 5	3 8
Doneness	4 4	4 4	4 0	3 6	3 9	3 9
Overall acceptability	22 6	22 2	20 7	18 4	20 0	22 2

Critical appraisal of the data showed that patties fried in F (RPO) had the maximum score for colour (3 8) flavour (3 6) and taste (3 8) While for other parameters like appearance taste doneness and texture maximum score was observed for patties fried in E (RPO sunflower and coconut oil) A (RPO and sunflower oil) /F (RPO) A (RPO and sunflower oil) /B (RPO and sesame oil) and B (RPO and sesame oil) respectively

Lowest score for colour (3 0) appearance (3 0) texture (3 1) taste (3 0) and doneness (3 6) was observed for the patties fr ed in the medium of D (RPO safflower and coconut oil) while that in the oil blend composed of RPO sunflower and coconut oil had the lowest for flavour (2 0) when compared with that made in other blends

Patties prepared in F (RPO) had higher scores (above 70 per cent) for all the quality parameters

Considering overall acceptability patties fr ed n A (RPO and sunflower oil) had the top score (22 6) followed by B (RPO and sesame oil 22 2) / F (RPO 22 2) C (RPO and groundnut oil 20 7) E (RPO sunflower and coconut oil 20) and lastly D (RPO safflower oil and coconut oil 18 4)

Table 9 Organoleptic qualities of product 3 (tapioca chips)

Quality parameters	Oil samples (mean scores)					
	A	B	C	D	E	F
Colour	3 9	4 1	3 0	2 6	4 3	3 7
Appearance	3 7	4 0	3 0	2 3	4 0	3 9
Flavour	3 4	2 6	2 6	2 5	3 6	4 3
Texture	4 6	3 9	4 ɔ	4 8	4 9	4 9
Taste	3 5	2 8	3 0	3 0	4 0	4 3
Overall acceptability	19 1	17 4	16 1	15 2	20 8	21 1

Unlike the trend observed n products 1 and 2 top scores in each quality parameter with product 3 was recorded by chips prepared n different oil samples Maximum score for colour appearance texture flavour and taste was observed in the chips made in the medium of E (RPO sunflower and coconut oil) B (RPO and sesame oil) /E (RPO sunflower and coconut oil) E (RPO sunflower and coconut oil) /F (RPO) and F (RPO) respectively

The minimum score for colour (2 6) appearance (2 3) and flavour (2 5) was for the chips prepared in the medium of D (RPO safflower oil and coconut oil) The samples prepared in B (RPO and sesame oil) scored the lowest value for texture and taste (2 8)

Chips prepared in RPO obta ned high scores (above 74 per cent) for all the parameters

While tak ng overall acceptability nto account chips fried in the medium of F (RPO) scored the highest (21 1) followed by the products fried in the media of E (RPO sunflower and coconut oil 20 8) A (RPO and

sunflower oil 19 1) B (RPO and sesame o l 17 4) D (RPO safflower and coconut oil 15 2) and C (RPO and groundnut oil 16 1)

4 6 Storage studies

The individual oils used in the blends had varying values for specific gravity moisture and similar characteristics which may have a profound influence on the storage qual ty of the blends Hence RPO and its blends were stored in airtight plastic containers for three months and analysed periodically to assess their storage stability The physico chemical parameters were analysed fortnightly for three months

4 6 1 Physical characteristics

The physical characteristics studied were specif c gravity and smoke point

4 6 1 1 Changes in specific gravity

Table 10 Changes in specific gravity due to storage

Oil samples	Storage durat on						Mean
	P	P_2	P_3	P_4	P_5	P_6	
A	0 924	0 924	0 924	0 924	0 925	0 925	0 925
B	0 926	0 926	0 926	0 926	0 927	0 927	0 926
C	0 917	0 917	0 917	0 918	0 918	0 918	0 918
D	0 916	0 916	0 916	0 916	0 918	0 918	0 917
E	0 924	0 924	0 924	0 925	0 925	0 925	0 925
F	0 925	0 925	0 925	0 926	0 926	0 926	0 926

Blends SE 2 657 E 04 Blends/storage per od SE 6 76 E 04
CD 8 190 E 04 CD 1 746 E 03
F 248 4 F 1 6

P F rst fortn ght P_2 Second fortn ght P Th rd fo tn ght
P_4 Fourth fortn ght P_5 F fth fortn ght P_6 S xth fo n g

Changes in specific gravity of RPO and different blends during storage for three months are depicted in Table 10 Among the six samples kept for storage C (RPO and groundnut oil) and D (RPO safflower and ground ut oil) had lower specific gravity compared to A (RPO and sunflower oil) B (RPO and sesame oil) E (RPO sunflower and coconut oil) and F (RPO) and this remained without much change till the end of storage period Close scrutiny of the data revealed that the specific gravity was almost steady throughout the storage per od

The changes in specific gravity of blends like A (RPO and sunflower oil) B (RPO and sesame oil) and D (RPO safflower and coconut oil) were observed after the second month of storage While similar change was observed in samples C (RPO and groundnut oil) E (RPO sunflower and coconut oil) and F (RPO) in the latter period of second month However the changes either during storage or among d fferent o l blends were not statistically significant

4 6 1 2 Changes in smoke point

Table 11 Changes in smoke point during storage (^{0}C)

Oil samples	Storage duration						Mean
	P	P_2	P_3	P_4	P_5	P_6	
A	180	178	173	170	169	167	173
B	176	175	171	168	165	162	169
C	170	169	167	165	163	161	166
D	191	188	183	180	176	174	182
E	195	189	184	180	177	172	183
F	190	189	185	180	178	173	183

Blends SE 0 225 Blends storage per od SE 0 387
CD 0 695 CD 1 095
F 1108 90** F 19 8**

**s gn f cant at one per cen level
P F rst fortn ght P_2 Second fortn ght P Th rd fortn ght
P Fourth fortn ght P_5 F fth fortn ght P_6 S xth fortn ght

The changes in smoke point of RPO and its blends during storage s depicted in Table 11 Among the samples D (RPO safflower and coconut

oil) F (RPO) and E (RPO sunflower and coconut oil) had higher smoke point when compared to A (RPO and sunflower oil) B (RPO and sesame oil) and C (RPO and groundnut oil) The smoke point of all the oil blends were found to decrease as the storage period progressed An individual decrease was observed in different blends Statistically significant variation in smoke point was observed among different oil blends and also for each blend during the storage per od

4 6 2 Chemical characteristics

The various chemical parameters studied were moisture content β carotene saponification value and iodine value

4 6 2 1 Changes in moisture content

Moisture content and specific gravity were the physical characteristics mainly studied Changes in moisture content of RPO and different blends due to storage is depicted in Table 12

- **Table 12 Changes in moisture content due to storage (per cent)**

Oil samples	Storage duration						Mean
	P_1	P_2	P_3	P_4	P_5	P_6	
A	0 0527	0 0543	0 0567	0 0580	0 0593	0 0617	0 057
B	0 0430	0 0480	0 0530	0 0613	0 0780	0 0867	0 062
C	0 0403	0 0487	0 0550	0 0600	0 0663	0 0707	0 057
D	0 0570	0 0590	0 0607	0 0627	0 0653	0 0677	0 062
E	0 0450	0 0477	0 0503	0 0537	0 0583	0 0660	0 054
F	0 0413	0 0487	0 0537	0 0587	0 0657	0 0747	0 057

Blends SE 1 669 E 04 Blends storage per od SE 3 847 E 04
CD 5 144 E 04 CD 1 088 E 03
F 380 82** F 204 09**

**s gn f'cant at one per cent level
P F rst fortn ght P_2 Second fortnight P_3 Th rd fortn ght
P Fourth fortn ght P_5 F fth fortn ght P_6 S xth for night

Table 12 details the changes in moisture content of RPO and different blends during storage for three months Among the six samples kept for storage B (RPO and sesame oil) C (RPO and groundnut oil) E (RPO sunflower and coconut oil) and F (RPO) had a low moisture value compared to A (RPO and sunflower oil) and D (RPO safflower and coconut oil) The rate of absorption of moisture by different blends during storage were also varying Blends such as B (RPO and sesame oil) C (RPO and groundnut oil) and F (RPO) were found to have higher affinity for moisture during storage even though the value in the initial period was lower for these blends In the case of the oil blends with higher moisture content initially the rate of absorption of moisture during storage was comparatively lower The moisture content at the end of storage was highest for the blends with high value pr or to storage The data indicated that there was significant increase in moisture content as the storage period progressed The rate of increase of moisture content among different blends were also found to be s gnificant

4 6 2 2 Changes in β carotene content (ppm)

Table 13 Changes in β carotene content during storage

Oil samples	Storage duration						Mean
	P	P_2	P_3	P_4	P_5	P_6	
A	472 0	459 0	450 6	307 6	303 0	249 6	373 6
B	356 3	343 6	340 3	320 3	272 3	252 0	314 1
C	260 3	200 3	180 3	180 3	157 0	140 0	186 4
D	530 3	512 3	420 0	369 3	349 6	344 6	421 1
E	358 ɔ	299 6	297 6	285 0	260 0	230 0	288 4
F	650 1	645 0	639 6	624 3	622 6	582 0	627 2

Blends SE 2 658 E 04
CD 5 242 E 02
F 1003256**

Blends/storage per od SE 5 875 E 04
CD 0 147 E 03
F 6446178**

**S gn f cant at one per cent level

Table 13 gives a detailed picture regarding the changes in β carotene content of different oil blends during storage F (RPO) had the highest β carotene content among different blends kept for storage D (RPO safflower and coconut oil) and A (RPO and sunflower oil) was observed to have higher level of β carotene when compared to E (RPO sunflower and coconut oil) B (RPO and sesame oil) and C (RPO and groundnut oil) β carotene was found to decrease during storage with variation among RPO and different blends The maximum loss was observed in A (RPO and sunflower oil) followed by E(RPO sunflower and coconut oil) C(RPO and groundnut oil) and B(RPO and sesame oil)/D(RPO safflower and coconut oil) The min mum loss was noted in F(RPO) There was significant difference in the rate of loss of β carotene among different oil blends and also in each blend due to storage

4 6 2 3 Changes in iodine value

Table 14 Changes in iodine value due to storage

Oil samples	Storage duration						Mean
	P_1	P_2	P_3	P_4	P_5	P_6	
A	63 0	60 3	78 6	82 0	66 0	68 3	69 7
B	62 0	64 6	75 0	79 3	62 3	62 0	67 5
C	63 6	67 6	75 3	75 0	61 3	61 6	67 4
D	72 0	77 3	77 3	78 6	64 0	62 0	71 8
E	65 6	69 6	82 0	82 3	66 0	64 3	71 6
F	47 6	51 0	46 6	51 0	48 3	48 3	49 1

Blends SE 0 374 E Blends storage per od SE 1 585
CD 1 152 E CD 4 484
F 529 035** F 7 184**
**S gn f cant at one per cen level

Table 14 give the details regarding tl e changes in odi e value of RPO and different blends dur ng storage for three months Among the samples stored F(RPO) had the lowest od ne value and D(RPO safflower and coconut o l) the h ghest when compared to A (RPO and sunflowe o l) B (RPO and sesame oil) C (RPO and groundnut oil) and E (RPO sunflower and coconut oil) It was noted that there was increase in the odine value of all the blends during the second month and a decrease afterwards The difference n iodine value between the blends and n each blend during storage was found to be statistically signif cant

4 6 2 4 Changes in saponification value

Table 15 Changes in saponification value due to storage

Oil samples	Storage duration						Mea
	P_1	P_2	P_3	P_4	P_5	P_6	
A	202 0	193 0	189 6	199 3	207 3	201 0	198 7
B	195 0	208 3	190 3	194 0	205 0	201 0	198 6
C	179 3	197 3	186 0	198 3	208 6	197 5	194 5
D	197 6	197 6	191 0	200 0	200 0	202 5	198 1
E	194 0	189 6	189 6	198 0	200 0	199 0	195 0
F	199 3	204 6	201 6	200 0	205 0	199 3	201 6

Blends SE 0 884 Blends s o age per od SE 705
CD 2 725 CD 4 823
F 8 93** F 8 34**
**S gn f can a one per cent level

Details regarding changes in sapnof cat on value due to storage s depicted in Table 15

Initially samples A (RPO and sunflower oil) F (RPO) D (RPO safflower and coconut oil) E (RPO sunflower and coconut oil) and B (RPO and sesame oil) were found to have higher sapon fication value when compared to C (RPO and groundnut oil) There was fluctuat on the saponif cation value of RPO and blends during the storage period Except in the case of B (RPO and sesame oil) saponification value was at the highest during the latter period of second month for all the blends However the variations among the blends and in each blend during storage were statistically significant

4 6 3 Organoleptic qualities of the products

The organoleptic qualities of the three products viz cake potato patties and tapioca chips were assessed monthly during the storage per od

Table 16 details the impact of stored o l blends on the organolept c qual ties of the product l prepared with these blends In this table the mean scores for the major six quality parameters assessed on the product l prepared w th the five blends and RPO stored for three months and drawn period cally once in a month are given

The mean scores obtained for colour revealed that the highest score was observed in the product prepared us ng A (RPO and sunflower o l) and F (RPO) followed by B (RPO and sesame oil) E (RPO sunflower and coconut oil) C (RPO and groundnut oil) and D (RPO safflower and coconut oil) An assessment of the fluctuation of scores obta ned for the qual ty parameters by the monthly assessment (P_1 P_2 P_3) indicates steady improvement in the case of products made using B (RPO and sesame oil)

Table 16 Impact of stored oil / blends on organoleptic qualities of product 1 (cake) (Mean scores)

Qual ty parameter / storage per od	A	B	C	D	E	F	
Colour							Blends
P	3 5	3 1	3 1	2 8	3 0	3 2	SE 0 106
P_2	3 3	3 2	3 0	2 6	3 2	3 4	F 8 82*
P	3 8	3 5	2 9	2 7	3 6	3 9	CD 0 30
Mean	3 5	3 3	3 0	2 7	3 2	ɔ 5	Blends storage per od
							SE 0 210
							F 0 86
							CD 0 590
Appearance							Blends
P	3 7	2 9	3 2	2 9	3 0	3 1	SE 0 109
P_2	3 9	2 9	3 5	3 3	3 1	3 5	F 8 15**
P	4 0	3 2	3 5	3 I	3 4	3 7	CD 0 311
Mean	3 9	3 0	3 4	3 1	3 2	3 4	Blends storage per od
							SE 0 197
							F 0 36
							CD 0 554
Flavour							Blends
P	2 9	2 4	2 1	2 8	2 7	3 0	SE 0 58
P_2	2 8	2 5	2 1	2 8	2 4	3 4	F 6 45**
P_3	3 6	3 0	2 8	2 6	3 1	3 2	CD 0 447
Mean	3 1	2 6	2 3	2 7	2 7	3 5	Blends storage per od
							SE 0 291
							F 0 75
							CD 0 8 6
Texture							Blends
P	3 5	3 6	3 6	3 3	3 5	3 5	SE 8 58 E 0 2
P_2	3 8	3 4	3 5	3 4	3 7	3 6	F 2 29
P_3	4 0	3 5	3 7	3 7	4 0	4 0	CD 0 24
Mean	3 8	3 5	3 6	3 5	3 7	3 7	Blends storage per od
							SE 0 181
							F 0 65
							CD 0 243
Taste							Blends
P	2 8	2 2	2 0	2 4	2 5	?9	SE 0 ɔ3
P_2	2 8	2 5	2 0	2 6	2 2	3 3	F 5 96**
P_3	3 5	3 0	3 0	3 0	3 1	3 9	CD 0 433
Mean	3 0	2 6	2 3	2 7	2 6	3 4	Blends storage per od
							SE 0 262
							F 0 37
							CD 0 733
Doneness							Blends
P	4 1	3 5	3 4	3 4	3 8	3 9	SE 0 1 4
P_2	3 8	3 6	3 4	3 6	4 0	4	F 6 46 *
P	4 1	3 7	3 4	3 8	4 3	4 3	CD 0 3 4
Mean	4 0	3 6	3 4	3 6	4 0	4 1	Blends storage pe od
							SE 0 207
							F 0 39
							CD 0 58
Overall acceptabil ty							
Fresh	19 8	17 0	17 3	17 2	17 8	18 7	
P	20 5	17 7	17 4	17 6	18 5	22 6	
P_2	20 4	18 1	17 5	18 3	18 6	21 3	
P_3	23 0	19 9	19 3	18 9	21 5	23 0	

*S gn f'cant at F ve per cent level **S gn f'cant at one per cent level
P F rst month P_2 Second month P Th rd month

E (RPO sunflower and coconut oil) and F (RPO) while there was consistent decrease in score value for colour for the product made using C (RPO and groundnut oil) while score values for A (RPO and sunflower oil) and D (RPO safflower and coconut oil) were not consistent The variation in the score value among the blends was found to be significant while comparison of score values obtained for the products prepared at the three stages of storage were not significant

The mean scores obtained for eye appeal e appearance indicated that product prepared using A (RPO and sunflower oil) scored high securing 3 9 followed by C (RPO and groundnut oil) F (RPO) E (RPO sunflower and coconut oil) D (RPO safflower and coconut oil) and finally B (RPO and sesame oil) On assessing the variation of scores for cake at different intervals it was noted that the scores for the product made with A (RPO and sunflower oil) B(RPO and sesame oil) C (RPO and groundnut oil) E (RPO sunflower and coconut oil) and F (RPO) were found to increase as the storage period advanced However in the case of B (RPO and sesame oil) and C (RPO and groundnut oil) difference in score values was not observed between first and second interval and between second and third interval respectively The scores obtained for products prepared with D (RPO safflower and coconut oil) were not found to be consistent A significant difference in appearance was noted among the blends on statistical interpretation but when the values for the cake prepared at monthly intervals were compared no significant difference was noted

Regarding the mean scores for flavour it was observed that the maximum score was for the cake prepared in F (RPO) followed by A (RPO

and sunflower oil) D (RPO safflower and coconut oil) /E (RPO sunflower and coconut oil) and B (RPO and sesame oil) while C (RPO and groundnut oil) had poor score ratings On verifying the change in score values of this product it was seen that scores for B (RPO and sesame oil) and C (RPO and groundnut oil) (second and third interval) increased with storage intervals whereas that of D (RPO safflower and coconut oil) was found to reduce during second and third intervals Interpretation of the statistical analysis of the data indicated that a significant difference existed between the cakes baked with various blends

It was evident from Table 16 that among the products made from RPO and f've different blends the texture attribute of cake baked in A (RPO and sunflower oil) obtained the highest and maximum score closely followed by E (RPO sunflower and coconut oil) /F (RPO) C (RPO and groundnut oil) and B (RPO and sesame oil)/D (RPO safflower and coconut oil) Close observation of the data also revealed the change in score values of the products baked with A (RPO and sunflower oil) D (RPO safflower and coconut oil) E (RPO sunflower and coconut oil) and F (RPO) which increased as storage time progressed while similar results were not observed in the case of B (RPO and sesame oil) and C (RPO and groundnut oil) The mean score depicted that there was no significant difference between the texture of cakes baked at consecutive months with different blends

On analysing the appreciation level on taste of cakes prepared w th RPO and its blends it was observed that the best tasted product was prepared using F followed by A (RPO and sunflower o l) D (RPO safflower and coconut oil) B (RPO and sesame oil)/E (RPO sunflower a id coconut oil) and

C (RPO and groundnut oil) The score values for the product prepared n B (RPO and sesame oil) D (RPO safflower and coconut oil) and F (RPO) have been found to be increase with time enhancement and similar trend was observed in the case of A (RPO and sunflower oil) and C (RPO and groundnut o l) only in the second month and third month of storage Inconsistency n this regard was discovered only in the case of E (RPO sunflower and coconut oil) Significant difference was noted among cakes baked with different oil blends but the difference was non sign ficant when the taste scores for the three storage duration was considered

In the evaluation of doneness of the product cake made us ng F (RPO) secured the highest value followed by E (RPO sunflower and coconut oil) B (RPO and sesame oil)/D (RPO safflower and coconut oil) and C (RPO and groundnut oil) In the case of A (RPO and sunflower oil) score values during the three intervals were not consistent Scores for the products prepared in B (RPO and sesame oil) D (RPO safflower and coconut oil) E (RPO sunflower and coconut oil) and F (RPO) increased steadily over the months while those of C (RPO and groundnut oil) remained constant throughout the study Statistical significance in variation of scores between blends were noted while that of scores at different storage periods were not significant

Overall acceptability of the cakes prepared in RPO and its blends was computed and it was noted that there was a steady increase in the overall acceptability of the products made using oil stored for three months had the max mum acceptance and among the oil samples A (RPO and sunflower oil)/F (RPO) secured the highest value followed by E (RPO sunflower and

coconut oil) B (RPO and sesame oil) C (RPO and groundnut oil) and D (RPO safflower and coconut oil)

Table 17 presents the scores of organoleptic qualities of shallow fried product prepared with stored RPO and its blends Six major quality parameters of the product (2) viz potato patties were assessed

While accounting the colour preference of patties made using RPO and oil blends of RPO it was noted that product fried in A (RPO and sunflower oil)/F (RPO) was most attractive followed by E (RPO sunflower and coconut oil) B (RPO and sesame oil) C (RPO and groundnut oil) and finally D (RPO safflower and coconut oil) The scores for A (RPO and sunflower oil) B (RPO and sesame oil) and E (RPO sunflower and coconut oil) increased over the storage period While inconsistent score values were observed in the case of C (RPO and groundnut oil) D (RPO safflower and coconut oil) and F (RPO) Colour of patties fried at different time intervals had no significant difference whereas scores obtained for patt es fr ed n different RPO/ blends were significantly different

Table 17 also indicates that among the patties prepared with stored RPO and blends the appearance attribute of A (RPO and sunflower oil) showed the highest value with a mean score 4 0 followed by F (RPO) B (RPO and sesame oil)/E (RPO sunflower and coconut oil) and C (RPO and groundnut oil) while the appearance of D (RPO safflower and coconut oil) was comparatively poor The score values for products prepared in A (RPO and sunflower oil) (during second and th rd interval) and E (RPO sunflower and coconut oil) were found to be increasing with time while for the remaining lower score values were observed during the second month

Table 17 Impact of stored oil / blends on organoleptic qualities of product 2 (potato patties) (Mean scores)

Quality parameter	A	B	C	D	E	F	
Colour							Blends
P	3 7	3 6	3 5	3 1	3 6	4 0	SE 0 172
							F 4 65**
							CD 0 487
P_2	4 0	3 6	3 2	2 9	3 7	3 8	Blends storage per od
							SE 0 189
P_3	4 3	4 1	3 3	3 4	4 3	4 3	F 0 87
							CD 0 531
Mean	4 0	3 8	3 3	3 1	3 9	4 0	
Appearance							Blends
P	3 8	3 8	3 6	3 2	3 6	3 9	SE 0 180
							F 2 17
P_2	3 8	3 6	3 4	3 0	3 7	3 7	CD 0 510
							Blends storage per od
P_3	4 6	3 8	3 7	3 7	3 9	4 1	SE 0 179
							F 0 88
Mean	4 0	3 7	3 6	3 3	3 7	3 9	CD 0 502
Flavour							Blends
P	3 7	3 5	3 0	2 8	2 4	3 8	SE 0 176
							F 4 84 *
P_2	3 6	3 3	3 2	2 8	3 5	3 7	CD 0 499
							Blends storage per od
P_3	4 1	3 8	2 9	3 3	4 1	4 1	SE 0 222
							F 0 68
Mean	3 8	3 5	3 0	3 0	3 7	3 9	CD 0 625
Texture							Blends
P	3 8	3 8	3 3	3 1	3 6	3 7	SE 0 75
							F 0 86
P_2	3 6	3 7	3 7	3 6	3 6	3 7	CD 0 496
							Blends storage per od
P_3	3 9	3 7	3 3	3 5	3 8	3 8	SE 0 204
							F 0 68
Mean	3 8	3 7	3 4	3 4	3 7	3 7	CD 0 575
Taste							Blends
P	3 9	3 8	3 4	3 3	3 6	4 0	SE 0 170
							F 2 17
P_2	3 7	3 4	3 6	3 3	3 6	3 9	CD 0 482
							Blends storage per od
P	4 2	4 1	3 1	3 8	4 0	4 1	SE 0 179
							F 1 57
Mean	3 9	3 8	3 4	3 5	3 7	4 0	CD 0 503
Doneness							Blends
P	4 6	4 5	4 2	3 8	4 0	4 1	SE 0 46
							F 4 35**
P_2	4 5	4 4	4 0	3 7	4 1	4 3	CD 0 4 4
							Blends storage per od
P_3	4 7	4 6	4 1	3 8	4 1	4 3	SE 0 178
							F 0 22
Mean	4 6	4 5	4	3 8	4 0	4 2	CD 0 501
Overall acceptability							
Fresh	22 6	22 2	20 7	18 4	20 0	22 2	
P	23 5	23 0	21 0	19 3	20 8	23 5	
P_2	23 2	22 0	21 1	19 3	22 2	23 1	
P_3	25 8	24 1	20 4	21 5	24 2	24 7	

*Significant at five per cent level **Significant at one per cent level
P First month P_2 Second month P_3 Third month

Statistical analysis indicated that differences in score values for appearance neither for patties made from RPO and different oil blends nor for storage periods were significant

When the flavour profile of patties fried in RPO and blends was taken into consideration it was noted that the sample F (RPO) had secured the highest score followed by A (RPO and sunflower oil) E (RPO sunflower and coconut oil) B (RPO and sesame oil) and C (RPO and groundnut oil) /D (RPO safflower and coconut oil) In the case of patties fried n the oil blends E (RPO sunflower and coconut o l) and D (RPO safflower and cocon t o l) (only at the th rd stage) the scores were seen to increase w th time while in the case of products prepared in the media of A (RPO and sunflower oil) B (RPO and sesame oil) and F (RPO) lower score values were observed The mean scores for the attribute flavour of the patties fried at different time intervals had no significant difference but there was a s gnificant difference n the scores of patties made with different oil blends

The data summarized in Table 17 reveals that the textural quality of patties fried in the medium A (RPO and sunflower oil) was most preferable to the judges followed by B (RPO and sesame oil)/E (RPO sunflower and coconut oil)/F (RPO) and C (RPO and groundnut oil) /D (RPO safflower and coconut oil) The constant scores for texture of patties fried n E (RPO sunflower and coconut oil) and F (RPO) were seen to increase in the third month while in the case of B (RPO and sesame oil) there was a decreas ng trend after the first interval Lower score values during the third nterval was observed in the case of C (RPO and groundnut oil) /D (RPO safflower and coconut oil) while similar trend was discovered in the second month n the

case of A (RPO and sunflower oil) The data when statistically interpreted was found to be non significant between time periods and with different blends

The mean score of patties obtained for the most important sensory characteristic taste was maximum in patties fried in the medium of F (RPO) closely followed by A (RPO and sunflower oil) B (RPO and sesame oil) E (RPO sunflower and coconut oil) D (RPO safflower and coconut oil) (RPO safflower and coconut oil) and C (RPO and groundnut oil) Score values for D (RPO safflower and coconut oil) (RPO safflower and coconut oil) and E (RPO sunflower and coconut oil) increased in the final period of storage Lower score values were observed for A (RPO and sunflower oil)/B (RPO and sesame oil)/F (RPO) dur ng the second month and for C (RPO and groundnut oil) during the third month Statistical analysis of the data revealed that no significant difference existed among the various oil blends and storage intervals

As indicated in Table 17 regarding the doneness of patties the ones prepared in A (RPO and sunflower oil) was most preferable followed by B (RPO and sesame oil) F (RPO) C (RPO and groundnut oil) E (RPO sunflower and coconut oil) and D (RPO safflower and coconut o l) (RPO safflower and coconut oil) Increase in score values were seen with E (RPO sunflower and coconut oil) and F (RPO) during the second month wh le lower score values were observed in the case of A (RPO and sunflower oil) B (RPO and sesame oil) C (RPO and groundnut oil) and D (RPO safflower and coconut oil) Statistically a significant difference was noted in the mean

scores for doneness of patties fried in different oil blends b it score values for patt es made during monthly intervals were non signif cant

On evaluation of overall acceptabil ty levels of patties fr ed in stored RPO and its blends the products prepared in A (RPO and sunflower oil) had a super or overall quality closely followed by F (RPO) B (RPO and sesame o l) E (RPO sunflower and coconut oil) C (RPO and groundnut oil) and D (RPO safflower and coconut oil) For all oil samples except C (RPO and groundnut oil) the score values were highest during the final period of observation n comparison that of fresh oil The increase in overall performance of potato patt es prepared in o l samples C (RPO and groundnut oil) D (RPO safflower and coconut oil) and E (RPO sunflower and cocon t o l) were study upto third month while with blends A (RPO and sunflower o l) B (RPO and sesame oil) and F (RPO) the change was slightly fluctuat ng during the second month

Table 18 gives the scores for sensory quality evaluation of product prepared by deep frying method us ng stored RPO and blends S x quality attributes were assessed on product ɔ viz tap oca ch ps

In the evaluation of colour t was seen that among the o l / blends B (RPO and sesame oil) secured the highest value followed by A (RPO and sunflower oil)/E (RPO sunflower and coconut oil) F (RPO) C (RPO and groundnut oil) and D (RPO safflower and coconut oil) Scores for A (RPO and sunflower oil) ncreased at the third month and that of Γ (RPO sunflower and coconut oil) decreased w th storage time Inconsistent score values were observed in the case of B (RPO and sesame oil) C (RPO and groundnut o l) D (RPO safflower and coconut o l) and F (RPO) where lower values were

Table 18 Impact of stored oil / blends on organoleptic qualities of product 3 (tapioca chips) (Mean scores)

Quality parameter	A	B	C	D	E	F	
Colour							Blends
P	4 0	4 2	3 3	2 4	4 2	3 9	SE 0 145
P_2	4 0	4 1	3 5	2 7	4 1	4 2	F 19 8**
P_3	4 2	4 3	3 1	2 6	3 9	3 7	CD 0 4 0
Mean	4 1	4 2	3 3	2 6	4 1	3 9	Blends storage per od
							SE 0 266
							F 0 41
							CD 0 748
Appearance							Blends
P	3 8	4 1	3 2	2 3	4 0	3 9	SE 0 129
P_2	3 8	4 1	3 3	2 4	3 8	3 9	F 27 33**
P_3	4 0	4 4	3 1	2 4	3 8	3 9	CD 0 365
Mean	3 9	4 2	3 2	2 4	3 9	3 9	Blends storage per od
							SE 0 239
							F 0 23
							CD 0 672
Flavour							Blends
P	3 5	2 7	2 8	2 6	3 7	4 4	SE 0 178
P_2	3 7	2 8	2 8	3 2	3 8	4 5	F 10 82**
P_3	3 5	3 1	3 2	3 3	3 7	4 ?	CD 0 504
Mean	3 6	3 9	2 9	3 0	3 7	4 4	Blends storage per od
							SE 0 330
							F 0 36
							CD 0 927
Texture							Blends
P	4 6	4 0	4 6	4 7	4 8	4 8	SE 0 101
P_2	4 6	4 0	4 5	4 6	4 8	4 8	F 5 83**
P_3	4 6	4 0	4 6	4 0	4 5	4 6	CD 0 287
Mean	4 6	4 0	4 6	4 4	4 7	4 7	Blends storage per od
							SE 0 190
							F 0 86
							CD 0 535
Taste							Blends
P	3 6	2 9	3 1	3 0	4 2	4 4	SE 0 139
P_2	3 9	2 9	3 3	3 1	4 3	4 8	F 22 67*
P	3 8	3 4	3 4	3 1	4 5	4 6	CD 0 395
Mean	3 8	3 1	3 3	3 1	4 3	4 6	Blends storage per od
							SE 0 271
							F 0 23
							CD 0 761
Overall acceptab l ty							
Fresh	19 1	17 4	16 1	15 2	20 8	21 1	
P	19 5	17 9	17 0	15 0	20 9	21 4	
P_2	20 0	17 9	17 4	16 0	20 8	22 2	
P_3	20 1	19 2	17 4	15 4	20 4	21 0	

*Signif cant at F ve per cent level **S gn f cant at one per cent level
P F rst month P_2 Second month P_3 Th rd month

observed in B (RPO and sesame oil) dur ng second interval and for the remaining same trend was observed in the third month Scores for colour of chips fried in RPO and blends were found to be significantly different as per statistical treatment unlike that of the observations at monthly intervals

Trials with tap oca chips fried n stored RPO and its blends revealed that the mean score obta ned for appearance of ch ps fr ed n B (RPO and sesame oil) was the best followed by A (RPO and sunflower oil)/E (RPO sunflower and coconut oil)/F (RPO) C (RPO and groundnut o l) and D (RPO safflower and coconut o l) The scores of A (RPO and sunflower oil) B (RPO and sesame oil) and D (RPO safflower and coconut o l) increased as a storage period advanced while the score values for C (RPO and groundnut o l) E (RPO sunflower and coconut oil) decreased Score values for A (RPO and sunflower oil) and B (RPO and sesame oil) was consistent during the f rst two months while s milar observations were noted for D (RPO safflower and coconut oil) dur ng the second and third months Scores for the medium F (RPO) rema ned constant throughout the period of study There ex sted a signif cant difference n the appearance character of ch ps fr ed n differe t blends but scores of chips fried period cally remained non s gn ficant

It is ev dent from the data presented in Table 18 tl it among the cl ips nade n RPO and five d fferent blends the flavour attribute of the product fried n F obta ned the h ghest and maximum score closely followed by B (RPO and sesame oil) E (RPO sunflower and coconut o l) A (RPO a d sunflower o l) D (RPO safflower and coconut oil) and C(RPO and groundnut oil) Close observation of the data revealed the change n score values of the product prepared in oil B (RPO and sesame oil) C (RPO and

groundnut oil) (only during the third interval) and D (RPO safflower and coconut oil) increase as storage time progressed The data showed that there was no significant difference between the flavour of chips fr ed dur ng three different months while significant difference was noted in score values of chips fried in different oil samples under study

Regarding the mean score for texture it was observed that the maximum score was for product prepared in E (RPO sunflower and coco iut oil) and F (RPO) followed by A (RPO and sunflower o l)/C (RPO and groundnut oil) D (RPO safflower and coconut oil) and B (RPO and sesame oil) On verifying the change in score values of the product t was seen that the scores for D (RPO safflower and coconut oil) E (RPO sunflower and coconut oil) and F (RPO) decreased with storage time while that of A (RPO and sunflower o l) and B (RPO and sesame oil) remained constant Decrease was observed only in the third month n the case of E (RPO sunflower and coconut oil) and F (RPO) while in the case of C (RPO and groundnut o l) decrease in score value was observed in second month and an increase in the third month Interpretation of the statistical analysis of the data ind cated a significant difference that existed in texture of chips fried in RPO and n various blends which was not the same in case of the score values of chips fried at monthly intervals

The taste attribute score of chips fried monthly in stored RPO and blends revealed that the product made in F (RPO) was most preferable to the judges followed by E (RPO sunflower and coconut oil) A (RPO and sunflower oil) C (RPO and groundnut oil) and B (RPO and sesame oil)/D (RPO safflower and coconut oil) Scores for B (RPO and sesame oil) C

(RPO and groundnut o l) D (RPO safflower and coconut o l) and E (RPO sunflower and coconut o l) ncreased dur ng storage In the case of A (RPO and sunflower oil) and F (RPO) there was a decrease in score value n the third month Increase n score value during the second month was observed in B (RPO and sesame oil) and dur ng the third month n B (RPO and sesan e oil) Interpretation of the statistical analys s of the data ind cated a signif cant difference that existed among chips fried in different samples while no significant difference was noted for ch ps made at three different storage periods

When the overall acceptability was computed based on sensory qualities the chips fried in F (RPO) showed high acceptance by the panel members followed by E (RPO sunflower and coconut o l) A (RPO a d su flower o l) B (RPO and sesame o l) C (RPO and groundnut o l) and D (RPO safflower and coconut oil) The values for overall acceptab lity was highest in the final month for the samples A (RPO and sunflower o l) B (RPO and sesame oil) and C (RPO and groundnut oil) and while that for D (RPO safflower and coconut o l) and F (RPO) the highest value was obtained in the second month Similar change was observed for E (RPO sunflower and coconut oil) in the first month It was a welcoming observat on that w th tl e o l samples A (RPO and sunflower oil) B (RPO and sesame oil) and C (RPO and groundnut oil) there was a steep rise in the overall liking of tap oca chips prepared with the stored oil when compared to the product prepared in fresh oil In the case of D (RPO safflower and coconut o l) and F (RPO) a constant increase in overall acceptability from that of fresh oil was evidenced by ch ps when prepared after stor ng upto second month

Results indicate that among the different products prepared using RPO and RPO blends potato patties was found to be the most acceptable followed by tapioca chips and cake Similarly among the oil samples under experiment RPO sunflower oil blend and RPO were observed to be the most preferred oils as medium of cooking as well as constituent in food

DISCUSSION

DISCUSSION

Vegetable oil has been one of the most important and inevitable components of our daily diet and has to be selected with caution India s exper encing a shortage of edible oil that may increase n years to come To meet this challenge our population needs to be famil arised with d fferent new oils and of these palm oil is the most important one

Palm oil is used in the crude form in many food preparations where t imparts its characteristic colour and flavour to the d shes A way to lessen these unwanted characteristic properties and to ntroduce palm oil as an acceptable oil into the household kitchen is to blend the oil with other vegetable oils by which housewives can be made to use the RPO in a more economical effective and beneficial manner

5 1 Identification of popular cooking oils

Fats and oils are found to have a very low prior ty in the daily d ets of Keralites Dietary surveys conducted by NNMB (1991) had revealed that average consumption of fats and oils by an adult in Kerala s only 44g Same trend in the oil consumption pattern is indicated in the KAU stud es conducted among adolescents (75g Beatrice 1999 and Kavitha 1999) elderly (5 10g Ajitha 2000) and children (10g Sreeja 1999)

The dietary preference of oil in a community can be assessed to a certain extent by the mobility of fats and oils in the local market Since the number of oils which are found to have continuous supply in the local shops

were only less than 10 of which coconut o l and palm oil (being cheaper) were found to be popular

5 2 Formulation and selection of oil blends

A salient point to be noted in this context is the steady increase in the prevalence of cardiac problems in Kerala which may be d e to the higi consumption of animal foods rich in fats or due to the prolonged consu npt o of certain vegetable oils rich in harmful constituents by a section of the population in the state Ghafoorunisa (1999) has advocated a combination of oils as a way of prevention of heart diseases According to her a si gle o l s likely to be more harmful than a mixture of o ls She has also reco nn ended that the da ly intake of visible fats should be 20 30 g with a comb iation of different vegetable oils which may be effective n mprov ng the l ealth prof le of the individual

RPO is one of the best oils since the fatty ac d compos tion is i tl e rat o of 50 40 10 for SFA MUFA PUFA and there is a need to popular ze its cont nuous use to maintain a healthy life But the colour and bland taste of the oil s reported to hinder the acceptability of this o l for common preparation in the da ly meal pattern of Keralites Hence based on the concept of the beneficial effects of us ng more than one oil in the da ly diet regimen an attempt was made to develop different oil blends with RPO n aintaining the P/S ratio between 0 8 1 Sunflower o l sesan e oil groundnut o l safflower and coconut o l when used n the blends were fo nd to make the colour and taste of RPO more acceptable at the same time reduc ng the harmful effects of the o ls used other than RPO Systemat c organolept c studies conducted on these oil blends also helped to ident fy the

suitable RPO oil blends with acceptable colour flavour miscibility and appearance

5 3 Physico chemical characteristics of RPO and RPO oil blends

When considering appl cation of the products with these blends the physical properties become very important In this experiment specific gravity and smoke point of the oil blends were the physical properties studied

Variation in specific gravity may influence the dripping quality of the oil which will be a deciding factor of the oil content of the product This factor may be responsible for the high preference of coconut oil wh ch is thinner and with a low value for specific gravity Among the different blends blend C (RPO and groundnut oil) and D (RPO safflower oil and coconut oil) were found to have better dripping quality

There was variation in smoke point for different oil blends Smoke point is found to be a major characteristic influenced by the nature and composition of an oil Stability culinary quality and shelf l fe qual ties of the oils are found to be influenced by this factor Proportion of RPO in the blend is also found to be a determinant of the smoke point of the blends Smoke point was noted to be higher in blends with greater proportion of RPO and this makes RPO more favourable in culinary aspects

Among the chemical characteristics moisture content iodine value saponification value and β carotene were determined in RPO and the blends

Moisture content of oil blends indicate the presence of free fatty acids which may be due to the hydrolysis of fat may lead to spoilage Blends C

(RPO and groundnut oil) and F (RPO) were found to have the lowest moisture level

Iod ne value helps to identify the nature of total fat n an oil Iod ne value was found to be the lowest in RPO and the value was in an increasing order in C (RPO and groundnut oil) D (RPO safflower and coconut oil) B (RPO and sesame oil) A (RPO and sunflower oil) and E (RPO sunflower and coconut oil)

Saponification value for different blends were also varying with the highest value observed in E (RPO sunflower and coconut oil) followed by A (RPO and sunflower oil) /D (RPO safflower and coconut oil) B (RPO and sesame oil) F (RPO) and C (RPO and groundnut oil) in the descending order

β carotene is the most important constituent present in oil w th antioxidant properties Among the different oil blends and RPO the latter s found to be the richest source of carotenoids while traces of carotenoids are found in other vegetable oils and the β carotene content of the blends was varied according to the proport on of RPO in the blends

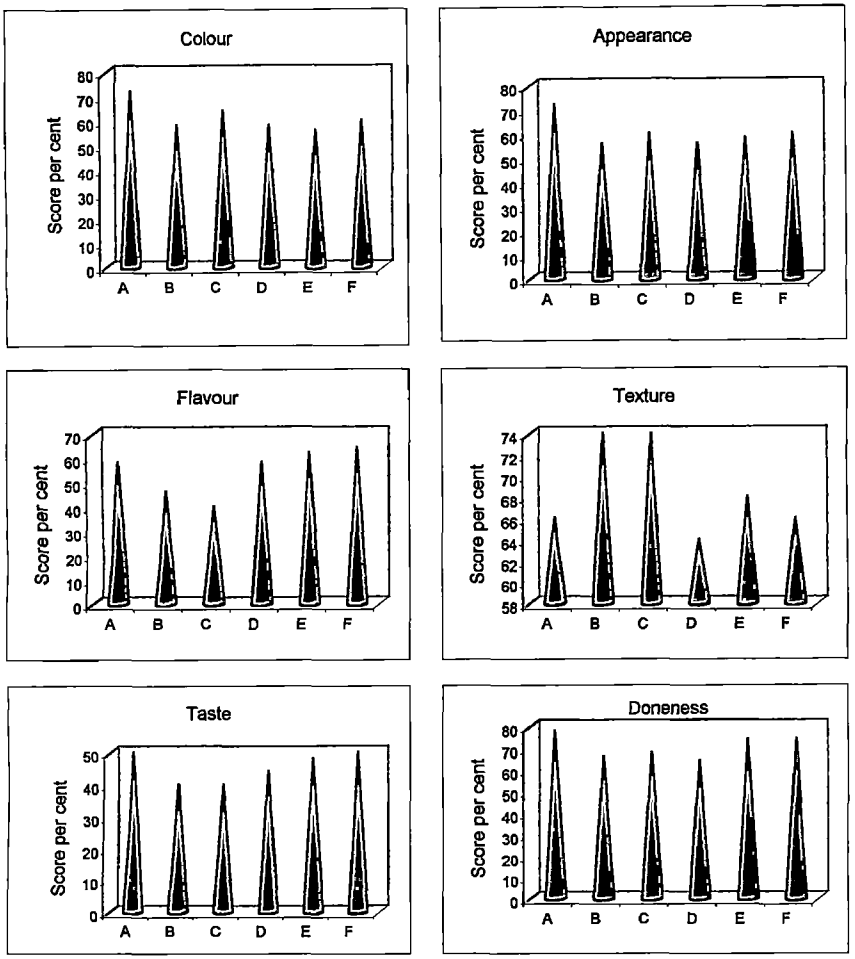
5 4 Organoleptic qualities of RPO and blends in products

Organoleptic qualit es of RPO and blends in products ind cate the acceptability of the products prepared using this as an essential ingredient or as the media for preparation Three products tried in this experiment are cake potato patties and tapioca chips

5 4 1 Cake (Fig 1)

The functionality of shortenings to be used in cakes depend on ts consistency and its capacity to trap and retain air bubbles within the batter

Fig 1 Organoleptic qualities of product 1 - Cake



A, B C D E F Oil Samples

As the batter is cooked the steam evolved diffuses into the existing a r cells and enlarges them The fat used will also favour the gelatinization of starch during baking An attempt was made in this study to test different RPO blends for their suitability to achieve the above targets As observed by Manorama and Rukmini (1991) the high solid content and level of high melting glycerides are useful parameters helping in the formulation of shortening and bakery fats

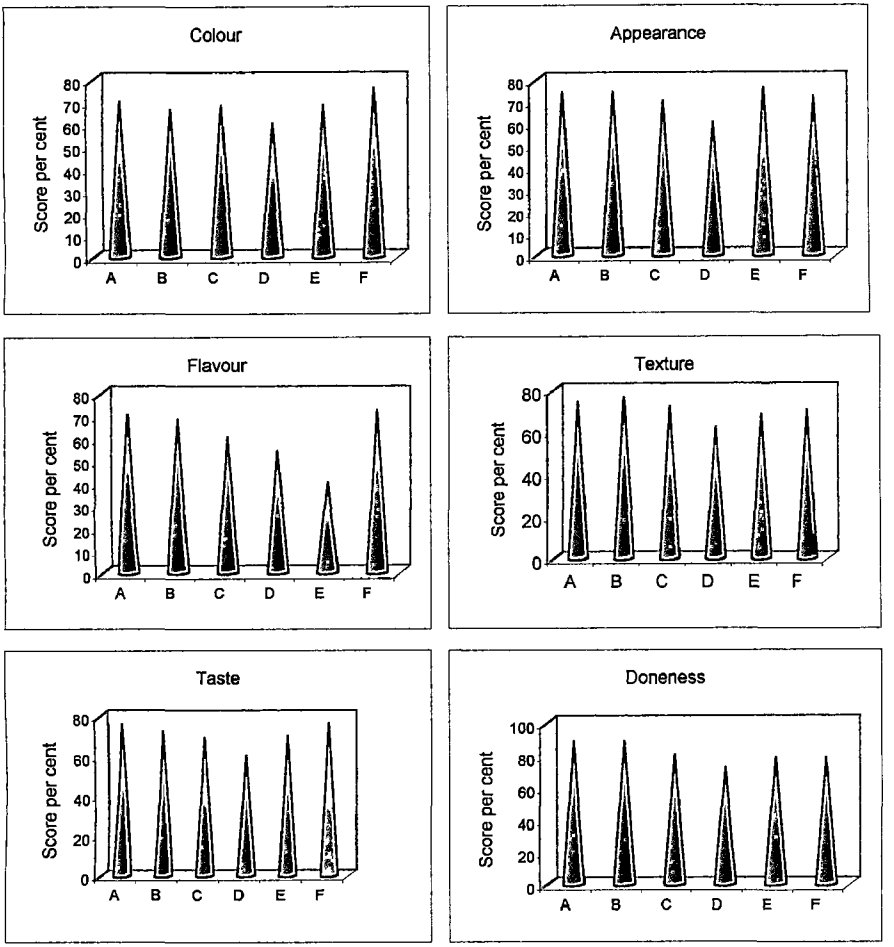
Analysis of the data elicited through the organoleptic evaluation of the products prepared with different oil blends revealed interesting observations Among the different quality parameters studied the product in which A (RPO sunflower blend) was incorporated was observed to obtain high scores for colour and appearance while the RPO and sesame oil blend and RPO and groundnut oil blends were found to have a positive influence on the texture and crumb structure of the cake When fats are used as shortenings there are special requirements in texture so that the product will not become too hard or too soft Different blends when subjected to the conditions of elevated temperature during baking might have behaved differently due to the structural and functional differences of fat constituents Sim larly the quality doneness was observed to be positively influenced by the incorporation of blends like A (RPO and sunflower o l) B (RPO and sesame o l) and F (RPO) On the other hand negat ve influence of the o l blends like B (RPO and sesame oil) and C (RPO and groundnut oil) was reflected in the qual ty parameters such as flavour and taste of the products Among the d fferent quality parameters studied RPO as well as its different blends were observed to have a negative impact in general on taste (Fig 1) RPO was found to be

suitable for preparations which completely take up the oil into the cooked product like cake and halwa (Manorama and Rukmini 1991) Partial replacement of butter with RPO in cakes was found to be well accepted (Idris 1995 and Archana 1999)

5 4 2 Potato patties (Fig 2)

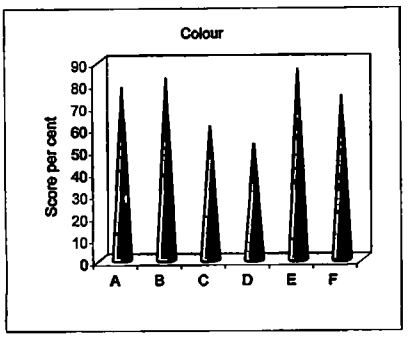
Palm oil is found to be suitable for shallow pan frying and deep frying Palm oil is one of the best frying fats (Anon 1990) The product prepared by shallow frying using RPO and blends in general were found to give better scores than the baked products in which these were one of the major ingredients Among the d fferent qualities studied appearance texture a d doneness were found to give very high scores The high scores obta ned for doneness indicate the suitability of this medium for preparing the product High scores obtained for the qual ty parameter appearance would also indicate the popular ty of oil blends among the consumers as a med a for fried preparations in future Unl ke the baked product high scores were also observed for taste in these products except those prepared w th C (RPO and groundnut oil) and D (RPO safflower and coconut oil) The overall acceptability scores obtained for the products made in the media of F (RPO) A (RPO and sunflower oil) and B (RPO and sesame oil) also gave encouraging results (Fig 2) Palm oil with its moderate linoleic acid content and very low linolenic acid content and high level of antioxidants is suitable for direct use n most frying applicat on Shallow fry ng reta ned the highest amount of beta carotene (Seshad r 199६)

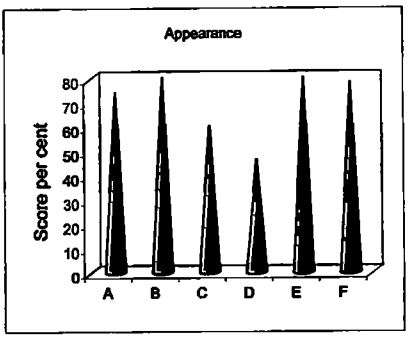
Fig 2 Organoleptic qualities of product 2 - Potato patties

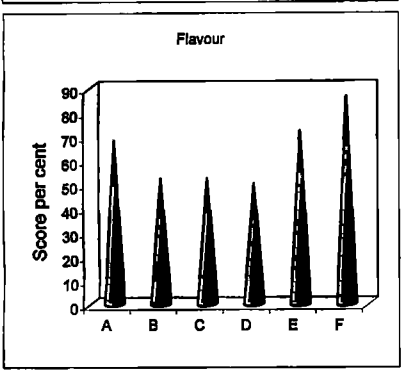


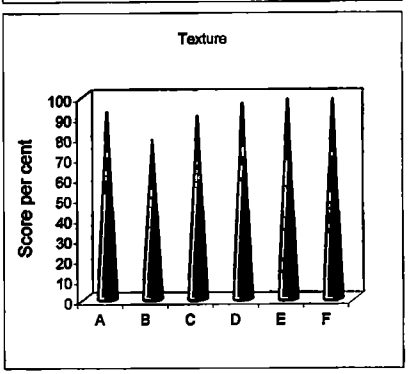
A B C D E F O I Samples

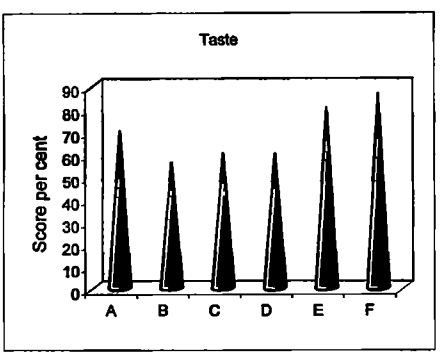
Fig 3 Organoleptic qualities of product 3 - Tapioca chips











A B C D E F Oil Samples

5 4 3 Tapioca chips (Fig 3)

The characteristic of an oil used for deep fry ng is ts ab l ty to with stand the high temperature used w thout excessive chemical cl ange F y ng potato chips was carr ed out at a temperature of about 180^{0}C A general observat on made in the organoleptic evaluat on of the product deep fried i RPO and d fferent blends revealed that RPO and few blends i e deilly suitable for preparing tap oca chips even though discourag ng observations were made with changes in colour of the products prepared in the media of C (RPO and groundnut oil) and D (RPO safflower o l and coconut oil) appearance in the media of D (RPO safflower oil and coconut oil) flavour in the media of B (RPO and sesame oil) and C (RPO and groundnut o l) taste in the media of B (RPO and sesame oil) Blends E (RPO sunflower oil and coconut oil) and F (RPO) were found to be acceptable and comparable standard products Overall acceptabil ty of these products also supports these observations (F g 3) Due to low polyunsaturated fatty acid content palm oil makes a good frying fat being stable to heat and less prone to ox dative polymer sat on and is used exte s vely in deep fat frying Ii Japan paln o l is mainly used as a deep fry ng fat n the food manufacturing ndustry (Min stry of Agriculture Forestry and F shery 1991) Palmolein or a blend of palmolein with soyabean or rapeseed oil is preferred for the large scale frying of potato crisps reported Lin (1991)

Observations on the organoleptic qualities of the three products indicate in general that RPO is a versat le ed ble o l w th benef c al effects and ts use can be expanded to increase in the community by disseminat ng the data generated

5 5 Storage studies

Storage study of different blends were conducted for three months and its influence on physico chemical characters and organoleptic qualities of the products prepared with the stored oil blends were assessed

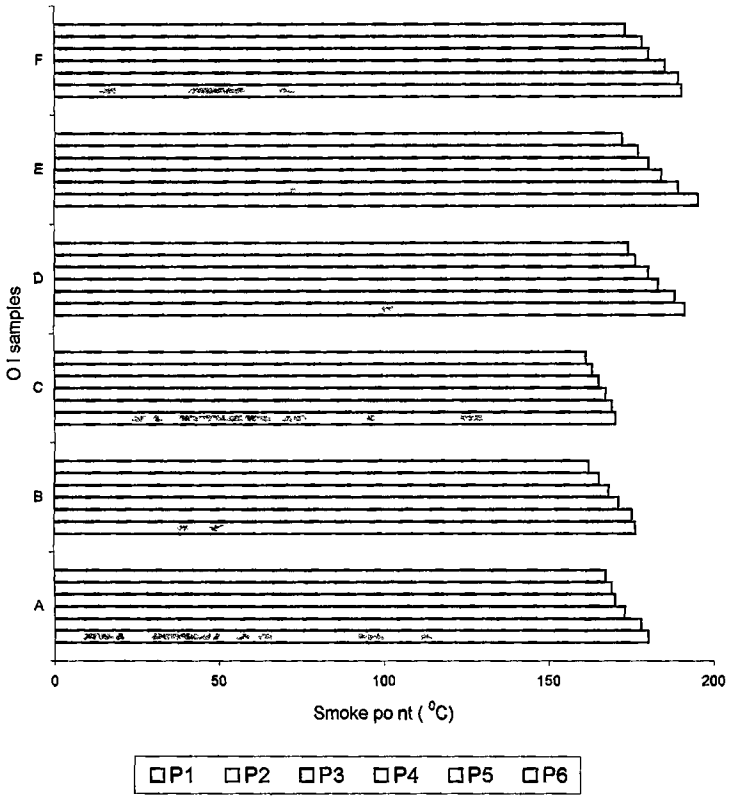
5 5 1 Change in physical properties

Stored samples were tested for specific gravity and smoke point

The specific gravity of stored RPO and oil blends was almost steady throughout the storage period Contamination of the oil blends by impurities may enhance the specific gravity But such a possibility can be ruled out in this experiment since the o l samples used were purchased from whole sale shops and stored in airtight containers Similar trend in specific gravity of RPO during storage was reported by Archana (1999) However Tyagi *et al* (1998) have observed a nonsignificant increase in specific grav ty of soybean oil blended with mustard o l / sesame oil

A decrease of smoke point with time in stored RPO and blends were observed during storage The decrease n smoke point might have been due to the enhancement in the content of free fatty acid probably due to the increase in moisture content (Fig 4) Change in smoke point dur ng storage was lowest in C (RPO and groundnut o l) followed by B (RPO and sesame oil) A (RPO and sunflower oil) E (RPO sunflower and coconut o l) F (RPO) and D (RPO safflower and coconut oil) Augustin *et al* (1987) had indicated that the decrease in smoke point during storage was regarded to be primarily a consequence of the increase in acidity Archana (1999) observed that smoke

Fig 4 Changes in smoke point during storage of oils



P First fortnight
P2 Second fortnight
P3 Third fortnight
P4 Fourth fortnight
P5 Fifth fortnight
P6 Sixth fortnight

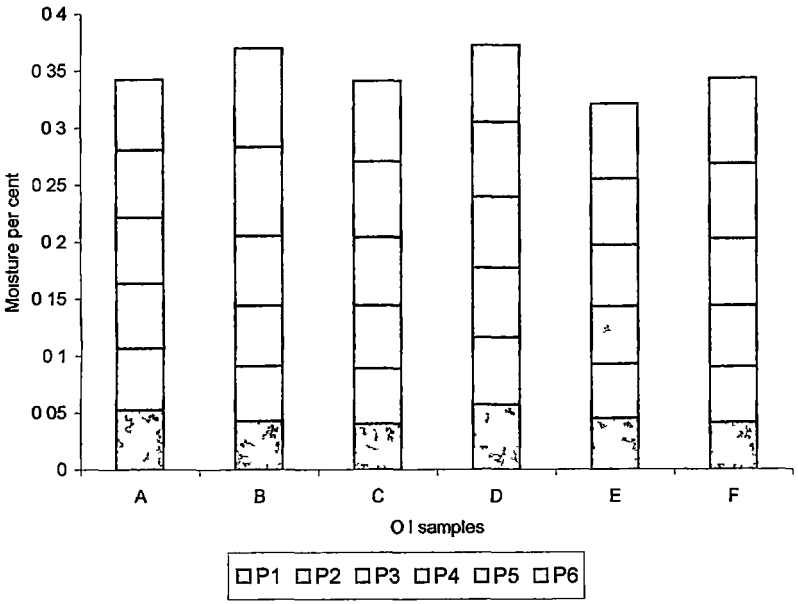
point decreased as free fatty acid in RPO increased showing that smoke point and free fatty acid content are inversely proportional

5 5 2 Change in chemical properties

There was a significant enhancement in moisture content of RPO and different blends with highest moisture content in B (RPO sesame oil blend) (Fig 5) The desirable level of moisture for edible oils are reported to be less than 0 2 per cent (Archana 1999) Presence of moisture leads to hydrolysis of fat resulting in release of free fatty acid and subsequent oxidation An increase in moisture content of the blends in this experiment might lead to an increase in free fatty acid content and later to spoilage if stored further Results of a study conducted by Sarojin and Bhavani (1997) have also indicated an increase in moisture content of RPO blended with sunflower oil/groundnut oil A similar result was obtained in a study conducted by Archana (1999)

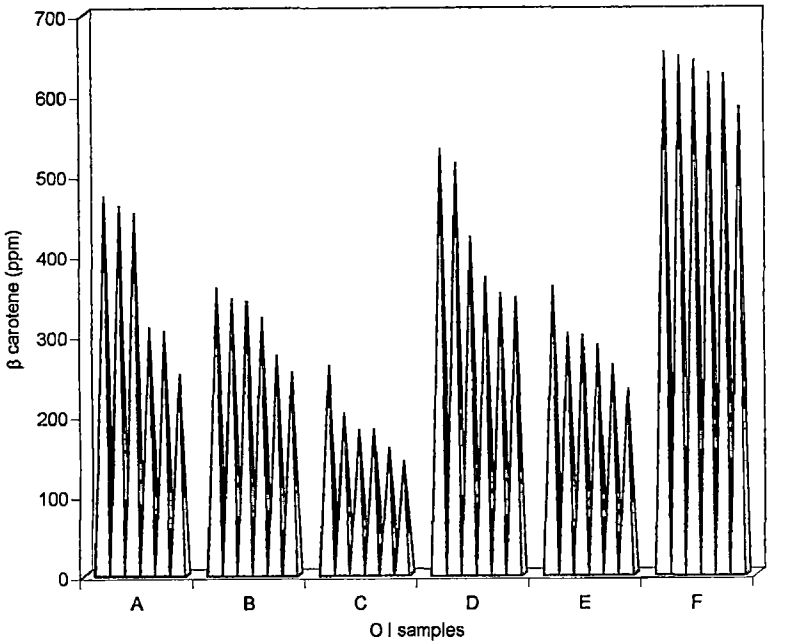
A significant decrease in β carotene in RPO and blends was noted This may be due to the oxidation of carotene during storage Reduction in β carotene during storage was lowest in C (RPO and groundnut oil) followed by E (RPO sunflower and coconut oil) A (RPO and sunflower oil) B (RPO and sesame oil) D (RPO safflower and coconut oil) and F (RPO) (Fig 6) Arumughan *et al* (1989) had reported that there was loss in carotene content when RPO was stored and the author also had stated that the loss may be due to the oxidation of carotene A similar result was observed by Archana (1999) on RPO storage studies In a study conducted by Lakshmi and Sarojini (1994)

Fig 5 Changes in moisture content during storage of oils



P F rst fortn ght
P2 Second fortnight
P3 Third fortnight
P4 Fourth fortn ght
P5 Fifth fortnight
P6 S xth fortnight

Fig 6 Changes in β carotene during storage of oils



P_1 First fortnight
P_2 Second fortn ght
P_3 Third fortn ght
P_4 Fourth fortnight
P_5 F fth fortn ght
P_6 Sixth fortn ght

t was observed that blending RPO with groundnut o l did not alter the stabil ty of caroteno ds in the stored RPO blends to any signif cant extent

Iodine value is an important ind cator of the shelf life quality of an oil (deterioration of an oil) In th s study there is fluctuation in the iod ne value of oil blends when determined per odically However the e was a s gnifica it decrease n the stored o l blends on completion of the storage study I a study conducted by Archana (1999) slight decrease was noted in iodine value of stored RPO samples Tyag *et al* (1998) also reported ı decrease n odine value of blends of soyabean oil w th mustard oil / sesame oil The decrease in iod ne value was reported to be due to the format on of peroxides Sarojini and Bhavan (1997) reported no sign ficant change in iod ne value during storage of RPO blends with sunflower o l and groundnut o l

Saponification of fats s used as an index to find out the molecular weight of fatty acids n a fat Fluctuation of saponificat on value of o l ble ids was observed when determined per od cally and there was a sign ficant variat on n the value of all the blends

5 5 3 Changes in organoleptic qualities

Changes in organoleptic q alit es of the products prepared usi g stored samples of oil blends through d fferent cook ng methods viz bak g shallow frying and deep fry ng were ascerta ned once n a month dur ig storage period

The sensory evaluat on stud es on baked product (cake) revealed sign f cant mprovement n all the qual ty attr butes l ke colour appearance flavour (except n D (RPO safflower and coconut o l) texture (except n B

Fig 7 Change in overall acceptability of cake

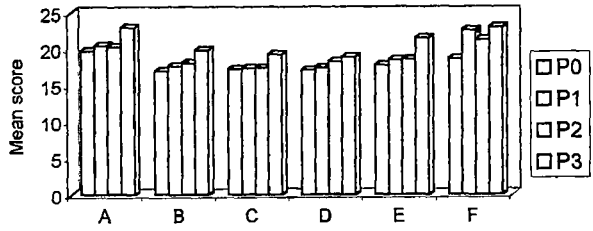


Fig 8 Change in overall acceptability of potato patties

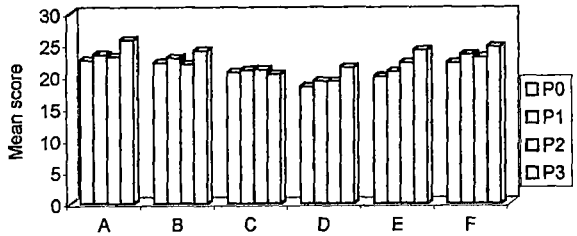
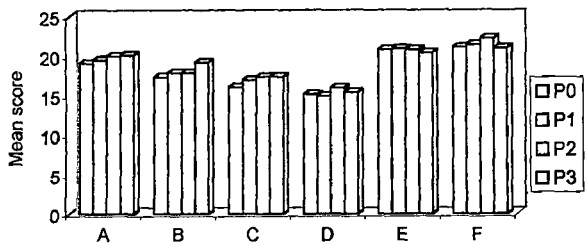


Fig 9 Change in overall acceptability of tapioca chips



P_0 Fresh P_1 First month P_2 Second month P_3 Third month

A B C D E F O I Samples

(RPO and sesame oil) taste and doneness (except in C (RPO and groundnut oil) On comparing the results on similar trials with fresh RPO and oil blends the product prepared using stored oil were recorded to be more appreciable (Fig 7)

Similarly the product prepared by shallow frying was observed to be more acceptable since the quality attributes like colour (except in C (RPO and groundnut oil)) flavour (except in C (RPO and groundnut o l)) taste (except in C (RPO and groundnut oil)) texture (except in B (RPO and sesame oil)/ C (RPO and groundnut oil)) appearance and doneness (except in C RPO and groundnut oil)) were observed to improve as the storage time progresses (Fig 8)

Easwaran and Shailaja (1988) have also reported that RPO is well acceptable for shallow fat frying and seasoning and similar results were observed in this experiment also in the RPO and in the blends in which higher proportion RPO was added

Trend in the changes in the organoleptic qualities of the potato chips were observed to be positive due to improvement in score values of qual ty attributes like colour (except n C (RPO and groundnut oil) D (RPO safflower and coconut oil) E (RPO sunflower and coconut oil) appearance (except in C (RPO and groundnut oil) E (RPO sunflower and coconut oil) F (RPO)) flavour (except in E (RPO sunflower and coconut o l) and F (RPO)) Unlike the earlier studies a decreasing trend in the score value for texture was noted in the tapioca chips (Fig 9) This can be attributed to the gradual crystallisation of palm oil which may result in structural hardness and texture deterioration in the finished product dur ng storage (Anon 1995) However due to the low PUFA content palm oil makes a good frying fat being stable

to heat and less prone to oxidative polymerisation and used extensively for deep fat frying (Manorama and Rukmini 1991)

Easwaran and Shailaja (1988) had reported that blended o ls could be accepted for deep fat frying They have also stated that RPO is very well suited for deep fat frying for selected products at selected blend ng with o ls like groundnut oil

5 6 Conclusion

RPO has several nutritional benefits which clearly distinguishes it from other common fats Palm oil is a rich source of monosaturates and is loaded with natural antioxidants such as vitamin E and carotene RPO has good shelf life and acceptability Thus the use of RPO based products could be recommended as the best dietary way of improving vitamin A status Partial replacement of RPO by beneficial oils like sunflower oil safflower oil etc and formation of blends may help to improve the health effects by improvii g composition n terms of PUFA content as well as the culinary properties of the oil blends Hence these blends can be advocated without fear of any compromise on the nutrit onal state of the people

SUMMARY

SUMMARY

This study was conducted to formulate blends of RPO to assess the r suitability for culinary purposes and to ascertain the physico chemical and organoleptic changes that occur during storage of RPO and blends

The salient findings of the study are given as follows

A shop survey conducted in Thiruvananthapuram district revealed that cooking oils popular among the local population were coconut o l palm oil sunflower oil sesame oil safflower oil groundnut oil mustard oil rapeseed oil soybean oil and butter

A number of blends of RPO with the above oils / fats were worked out in different proportions and based on the P/S ratio ten blends viz RPO and sunflower oil (60 40) RPO and safflower oil (65 35) RPO and sesame oil (40 60) RPO and groundnut oil (30 70) RPO and mustard oil (30 70) RPO and rapeseed oil (30 70) RPO and soyabean oil (60 40) RPO soyabean oil and coconut oil (50 45 5) RPO safflower and coconut oil (60 35 5) and RPO sunflower and coconut oil (50 45 5) were formulated

These blends were subjected to hedonic rating to ascertain the sensory qualities and five blends that exhibited better miscibility flavour colour and appearance were screened The selected blends were RPO and sunflower o l blend (60 40) RPO and sesame o l blend (40 60) RPO and groundnut oil blend (30 70) RPO safflower oil and coconut oil blend (60 35 5) and RPO sunflower and coconut o l blend (50 45 5)

Laboratory estimations were carr ed out on RPO and on the screened blends to ascertain their physico chemical characteristics and were also tested

for their cooking qualities Analysis of physico chemical characteristics of fresh RPO and blends indicated lowest values for specific gravity for RPO followed by safflower and coconut blend and for moisture content RPO and groundnut oil blend Highest value for smoke point were observed for RPO sunflower and coconut oil blend and for β carotene RPO was found to be the richest

The cooking qualities of RPO and selected blends were studied by preparing three products viz a product in which oil blends were essential ingredients (cake) another two products prepared in the media of oil blends through shallow fry ng (potato patties) and deep fry ng (tap oca ch ps) methods

Organoleptic qualities of the cake baked in fresh RPO and blends revealed RPO and sunflower oil blend as the most suitable one followed by RPO RPO sunflower and coconut oil blend RPO and groundnut oil blend RPO safflower and coconut oil blend and finally RPO and sesame oil blend

Overall acceptability of potato patties prepared in RPO and sunflower oil blend had the highest scores followed by RPO and sesame oil/ RPO and groundnut oil blend RPO sunflower and coconut oil blend and lastly RPO safflower and coconut oil blend

Tapioca chips fried in fresh RPO and blends revealed that the product fried in RPO scored highest followed by the products prepared in the media of RPO sunflower and coconut o l blend RPO and sunflower oil blend RPO and sesame oil blend RPO safflower and coconut oil blend and RPO and groundnut oil blend in the descending order

Blends prepared with different oils varying in mo sture spec fic gravity iodine value and saponification value may have problems related to their shelf life Hence indepth studies on physico chemical qualities and organoleptic qualities of stored blends and RPO were also taken up

Physico chemical characteristics of stored RPO and blends were assessed fortnightly for three months The moisture content of the oil blends were seen to increase during storage RPO and sesame oil blend had the highest moisture content followed by RPO RPO and groundnut oil blend RPO safflower and coconut oil blend RPO sunflower and coconut oil blend and RPO and sunflower oil blend

No change in specific gravity of the blends in general were observed during storage period In fresh samples RPO safflower and coconut oil blend had the lowest specific gravity followed by RPO and groundnut o l blend RPO and sunflower oil blend/ RPO sunflower and coconut oil blend RPO and RPO and sesame oil blend After storage lowest specific gravity was seen in RPO safflower and coconut oil blend / RPO and groundnut oil blend

Smoke po nt of all the blends decreased dur ng storage However RPO safflower and coconut oil blend were found to retain the highest smoke point and the lowest was for RP O and groundnut oil blend

β Carotene content of all the blends decreased during storage RPO had the highest β carotene content followed by RPO safflower and coconut o l blend

Iodine value of all the blends increased dur ng second month and then found reducing Stored RPO had the lowest iodine value

A fluctuation in the saponification value of RPO and blends was noted during storage RPO and groundnut oil blend had the lowest saponification value and RPO sunflower and coconut oil had the highest saponification value After storage lowest saponification value was seen in the same blend

Cake baked with stored RPO and oil blends revealed that RPO and sunflower oil blend/ RPO alone was the best for baking cakes Among fresh samples cake baked with RPO and sunflower oil blend was the best followed by RPO alone

On evaluation of potato patties fried in stored RPO and blends the products prepared during third month of storage was found to be the most preferable Similar to that of fresh sample among stored samples RPO and sunflower oil blend was found to be the most appropriate medium for shallow frying

The sensory qualities of tapioca chips fried in stored RPO and ts blends was found to be the highest in the third month with regard to three blends viz RPO and sunflower oil blend RPO and sesame o l blend and RPO and groundnut oil blend For deep frying RPO proved to be the best med um among the fresh and stored oil samples

Moisture content specific gravity smoke point are the major phys co chemical characteristics which may nfluence the organoleptic qualities of the products prepared with the blends or in their medium However in the blends there may be variation in these natural properties Among the different blends RPO and sunflower oil blend (60 40) is found to have better physico chemical characteristics as well as organoleptic qualities It was observed that storage of RPO and blends have improved their organoleptic propert es

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*Origi al not seen

APPENDICES

APPENDIX II

SCORE CARD FOR ASSESSING THE QUALITY PARAMETERS OF OIL BLENDS

Sl No	Oil blends	Score				
		Appearance	Colour	Flavour	Miscibility	Total
1	A					
2	B					
3	C					
4	D					
5	E					
6	F					
7	G					
8	H					
9	I					
10	J					

Excellent 5
Very good 4
Good 3
Fair 2
Poor 1

Signature

APPENDIX – III

EVALUATION CARD FOR TRIANGLE TEST

In the triangle test three sets of sugar solution of different concentration were used Of the three sets two solutions were of identical concentrations and the members were asked to identify the third sample which was of d fferent concentration

Name of the product Sugar solution

Note Two of the three samples are identical ident fy the odd sample

Sl No	Code No of the samples	Code No of the identical samples	Code No of the odd sample
1	XYZ		
2	ABC		

Signature

APPENDIX IV

SCORE CARD FOR ASSESSING THE ORGANOLEPTIC QUALITIES OF CAKE

Quality grade description	Score	A	B	C	D	E	F
COLOUR							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
APPEARANCE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
FLAVOUR							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
TEXTURE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
TASTE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
DONENESS							
Well done	5						
Satisfactorily done	4						
Partially done	3						
Moderately done	2						
Under cooked	1						

Signature

APPENDIX V

SCORE CARD FOR ASSESSING THE ORGANOLEPTIC QUALITIES OF POTATO CHIPS

Quality grade description	Score	A	B	C	D	E	F
COLOUR							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
APPEARANCE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
FLAVOUR							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
TEXTURE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
TASTE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
DONENESS							
Well done	5						
Satisfactorily done	4						
Partially done	3						
Moderately done	2						
Under cooked	1						

Signature

APPENDIX VI

SCORE CARD FOR ASSESSING THE ORGANOLEPTIC QUALITIES OF TAPIOCA CHIPS

Quality grade description	Score	A	B	C	D	E	F
COLOUR							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
APPEARANCE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
FLAVOUR							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
TEXTURE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						
TASTE							
Excellent	5						
Very good	4						
Good	3						
Fair	2						
Poor	1						

Signature

SUITABILITY OF RED PALM OIL AND ITS BLENDS FOR CULINARY PURPOSES

By

SMITHA SREEKUMAR

ABSTRACT OF THE THESIS
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COLLEGE OF AGRICULTURE
VELLAYANI
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2001

ABSTRACT

The study entitled Suitability of RPO and its blends for culinary purposes is a comprehens ve study carr ed out with an objective to formulate blends of red palm o l w th other o ls/fats and to evaluate a cul nary performance of RPO and blends in selective preparation The study also envisages the physico chemical and organoleptic changes dur ng storage of RPO and blends

A shop survey was conducted in Thiruvananthapuram d str ct to ident fy the popular cooking oils/fat Maintaining the P/S ratio between 0 8 1 ten blends were formulated using RPO and popular culinary oils Tl ese blends were subjected to hedon c rating to select five blends that ind cated higher acceptabil ty The o l samples thus selected for the study were RPO and sunflower o l blend (60 40) RPO and sesame oil blend (40 60) RPO and groundnut oil blend (30 70) RPO safflower oil and coconut oil blend (60 35 5) RPO sunflower oil and coconut oil blend (50 45 5) and RPO alone

Physico chem cal characteristics of fresh oil (RPO and blends) viz spec f c grav ty smoke point moisture content iodine value saponification value and β carotene were ascertained Spec f c gravity was lowest n RPO safflower oil and coconut oil blend and highest smoke point was observed in RPO sunflower o l and coconut oil blend Moisture content was lowest n RPO and groundnut o l blend Meanwh le RPO was found to be the r chest n β carotene

Storage studies to assess the change in phys co chem cal parameters and organoleptic qualit es of RPO and blends were taken up for a per od of

three months The physico chemical analysis were conducted fortnightly for three months

During storage specific gravity remained almost steady whereas smoke point decreased Moisture content of the oil samples showed a visible increase while a fluctuation was noted in the iodine value and saponification value with stored oil samples β carotene content was found to decrease during storage

Study on cooking qualities of RPO and blends were conducted by preparing three products viz cake potato patties and tapioca chips Monthly evaluation of products prepared using the stored RPO and blends revealed that cakes and potato patties made using stored RPO and sunflower oil blend was found to be the most preferred Tap oca chips fried in stored RPO was proved to be the most acceptable Results also revealed that products prepared using stored oil samples were found to have better acceptability than those with fresh samples

Results of the study indicated that RPO and its blends are acceptable for different food uses and it is feasible to promote its consumption in domestic kitchen as well as in the industry Present trials also evidenced that these oils are best as frying fats especially shallow frying Among the different oil samples studied RPO and sunflower oil blend was found to be the most appropriate followed by RPO for culinary purposes