NUTRITIONAL STUDIES ON DEHYDRATED OYSTER MUSHROOMS AND THEIR UTILIZATION IN PRODUCT DEVELOPMENT

by

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THESIS
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DECLARATION

I hereby declare that this thesis entitled Nutritional studies on dehydrated Oyster mushrooms and their utilization in product development is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree diploma associateship fellowship or other similar title of any other University or society

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CERTIFICATE

Certified that the thesis entitled Nutritional studies on dehydrated Oyster mushrooms and their utilization in product development is a record of research work done independently by Miss Hema V under my guidance and supervision and that it has not previously formed the basis for the award of any degree fellowship or associateship to her

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Introduction

INTRODUCTION

Mushrooms are plants which belong to a group called Fungi Generally the term mushroom is used to denote the fleshy body of higher fungi The mushrooms have been used by man from the time immemorial and their use for culinary purposes is closely related to the history of mankind (Suharban 1987) Use of mushrooms as evidenced by litrature dates back to 3000 B C in India (Pathak 1986) They are highly priced as food delicacies are eagerly sought after for their innate flavour and taste appeal As mushroom represent one of the world s greatest untapped resources of nutrition and palatable food mushroom growing is at present gaining momentum in many countries including India

Initially only wild mushrooms were collected and consumed where as their domestication started around 1700 years in France (Bhavani Devi 1982) Oyster mushrooms (Pleurotus) is the fourth important cultivated mushroom of the world and constitute about 2 7 percent of the total production of fresh mushroom (Singh 1988) The

cult vat1on of Pleurotus spec1es are becom1ng 1ncreas1ngly popular among the mushroom farmers In Ind1a commerc1al cultivat1on 1s extented to three mushrooms namely white button mushroom (Agar1cus b sporus) Paddy straw mushroom (Volvar1ella sp) and oyster mushroom (Pleurotus sp)

Apart from be1ng tasty ed1ble mushrooms are nutr1t1ous and add valuable prote1n v1tam1ns and m1nerals to the vegeter1an d1et They are blended w1th other food products and made more tast1er and nutr1t1ous Mushroom soups mushroom fr ed r1ce mushroom cutlets mushroom t1kk1s mushroom omelette mushroom pakoda and baked tomatoes w1th mushroom are some of the del1cac1es made w1th mushrooms (Obero1 1989) Mushroom p1ckles and ketch up were also well accepted products (Padmavathy 1991)

A suff1c1ent calor1e 1ntake does not quarantee a good standard of nutr1t1on Food contain1ng m1nerals v1tam1ns and enough of the r1ght k1nd of prote1n 1s necessary 1n add1t1on to furn1sh1ng energy Though the

protein is synthesized tremendously by green plants the concentration of protein in plants with a few exceptions is quite low in terms of the percentage of total weight Mushrooms provide a rich addition to the diet in the form of proteins valuable salts and vitamins Mushroom proteins are comparable to muscle protein in nutritive value Mushrooms are well suited to supplement diets which lack protein and in the sense they have rightly been called Vegetable meat They possess good quality protein (20 40 percent on dry weight) essential amino acids and good source of B vitamins They are high in mineral content and are superior in protein content to all the vegetables and fruits They are nearly devoid of starch and sugar and hence exceedingly useful for diabetic patients Since it has low calorie and rich in fibre they are highly thought of by many modern nutritionists

Growing edible mushroom is gaining momentum in recent years and with adequate financial assistance and market support it could be developed into a sound agro based industry providing employment opportunities particularly for the women folk (Jayarajan 1990)

Mushrooms along with pulses and soyabeans will ultimately help in warding off protein malnutrition The short shelf life of commonly grown mushrooms possess a big problem for mushroom growers It is in this context arises the need for developing products with mushrooms with high acceptability and shelf life qualities Hence a study has been planned to assess the nutritional qualities of dehydrated oyster mushrooms and their utilization in product development

The present study is an attempt

a To assess the nutritional value of dehydrated mushroom flour

b To evaluate the quality of proteins in dehydrated oyster mushroom powder

c To develop and standardize an acceptable product such as mushroom wafers with blends of mushroom powder and black gram flour

d To assess their shelflife qualities for a period of one year

Review of literature

REVIEW OF LITERATURE

Systematic study of the fungal flora in India started after Linnaeus and Koenig in the seventeenth century (Suharban 1987) In India Newton was the first to grow mushroom (Bhawani Devi 1988) There are nearly 2000 species of which about a dozen or more are safely consumed in different parts of Ind a (Suharban 1987) Sivaprakasan *et al* (1986) reported a new pleurotus species called *Pleurotus citrinopileatus* from lower Palney Hills The scientists of Tamil Nadu Agr cultural University have developed techniques for cultivating this mushroom and released it as CO_1 during 1987 The total world production of cultivated mushrooms is estimated to be around 20 lakh tonnes in 1987 21 lakhs tonnes in 1991 and excess of one m llion tonnes in 1993 (Shanmugham 1993) Mushrooms can be grown in any household in any part of the country during any season due to a break through achieved in farming techniques of the oyster mushroom at the National Centre for Mushroom Research and Training (Sohi 1986) Apart from being an easy source of

food at home t has the potential of being cult vated as a prof table commercial crop without much investment (Nair 1988) It is possible to grow several heavy crops of mushroom in a year and its intensive cultivation and h gh yield can compensate for the protein content of mushroom and can be compared more favourably with other crops n terms of yield per unit area Cereals give an annual yield of 3000 to 6000 kg/hectare but mushroom may give upto 2 million kg/ha (Cooke 1989)

Oyster mushroom cultivation

The cultivation of oyster mushroom or pleurotus species as a class of edible mushroom has gained popularity in recent years (Bano and Rajarathnam 1982) Oyster mushrooms are better in cultivation and consumer aspects than the generally grown button mushroom (Sohi 1986) It is b gger and brighter with a larger shelf life suited for tropical paddy growing areas and they thrive well on temperature ranging between 70° and 100°F w th 65 80 percent humidity (Pathak 1986) Among different cultivated edible fungi species of pleurotus

mushroom are the easiest and cheapest to grow Chadha et al (1994) The oyster mushroom which belongs to the genus Pleurotus include many species which are Pleurotus sajor caju, Pleurotus ostreatus, Pleurotus sapidus, pleurotus florida and Pleurotus citrinopileatus (Jandaik 1988)

The recently released Pleurotus species - Pleurotus citrinopileatus has become very popular among the growers in Co mbatore in a very short time (Shanmugham 1989) Although different industrial methods of oyster mushroom production have been developed further probing on innovative methods like use of locally available substrate and simplification of available methods of cultivation which may bring about an increased yield and bioefficiency of oyster mushrooms are to be encouraged (Sethi and Anand 1991)

Post Harvest Care of mushrooms

A bright colour is a major requirement for the successful marketing of mushroom (Gormley 1986) Post harvest quality loss of mushroom is a major economic

problem for producers and retailers since mushroom is an easily perishable food item The deterioration of quality is expressed as cap browning cab development visible microbial growth and loss of texture (Burton 1988) Gormley and Mccanna (1987) reported that the mushrooms covered with a synthetic PVC film (polyvinyle chloride film) lose water and whiteness at a much slower rate than uncovered mushrooms They suspected that the change in colour is due to loss in moisture Mushrooms stored at 21^{o} C remained whiter than those stored at 1^{o}C or 11 ^{o}C but they mature at a much faster rate The loss of whiteness during storage is due to the browning reactions occuring in mushrooms The new grower who produce high quality mushroom must apply the best post harvest techniques to the crop to ensure that the quality is maintained (Frost 1989) The short life of mushroom can be extended by cool storage (Nicholas and Hammond 1984) Browning of the mushroom cap is probably the main criterion of quality Frost et al (1989) Fresh mushroom have an active enzyme system which is related during damage on rough handling (Gormley 1986) One cause of

mushroom discolouration is the enzyme tyrosinase oxidation of colourless phenols to form quinones which react to form the familiar brown pigment (Burton 1986 and Nicholas 1988) Control of polyphenol oxidases activity by use of c tric acid was studied by Mccord et al (1983) Washing with a solution containing a reducing agent like sodium bisulphite may prevent browning (Nicholas 1988) Low CO_2 concentration upto 2 5 percent is reported to reduce brown discolouration (Lopez Briones 1992) The process for preservation of mushrooms by mixing it with the juice preparation and preservation of mushroom juice mix by freezing pasteurization and vaccum packaging was reported by (Dubois 1992)

Bano and Patwardhan (1989) reported that mushrooms packed in fibre board trays covered with an inverted tray to reduce desiccation show a maximum shelf life of 7 days when kept at $1^{o}C$ for 5 days and $20^{o}C$ for the next 2 days

Robb et al (1984) reported that mushrooms contain a very active and relatively abundant tyrosinase

wh ch contr1butes to the enzymat1c brown1ng react ons 1n mushrooms Mushroom tyros nase has been extens vely studied dur1ng post harvest treatments and storage

Burton et al (1989) have conducted stud es as these en⁄ymes on d fferent strains of Aqar1cus spec1es It 1s found that the mushrooms stored at 21°C hardened at faster rate than mushrooms stored at 11°C or 1°C Toughen1ng and degree of matur1ty were greatest at 21°C

Mushrooms have a h gh rate of respirat1on and hence proper attent1on should be g1ven dur1ng storage In Western countr1es the white button mushrooms are covered w1th PVC f1lm and have a shelf l1fe of 5 7 days at 15°C to 21°C temperature dur1ng transportat1on Uncovered mushrooms have 2 4 days of shelf l fe under s1m1lar condit1ons (L1tchfield 1990)

Burton et al (1989) reported a combinat1on of plast1c permeable f1lm system for controll1ng post harvest mushroom qual1ty A combinat1on of m1croporous and a relat1vely 1mpermeable f1lm was used to overwrap mushrooms The mod f1ed atmosphere created by respirat1on

could be controlled by adjusting the area of microporous film which inturn reduced loss of mushroom quality as assessed by colour weightloss and d sease incidence

Rai and Sanjeev Saxena(1991) reported the effect of storage temperature on vitamin C content of mushrooms Button mushrooms in polythene perforated packets were stored at 5^{o}C and 85 90% relative humid ty at 10^{o}C and 70 75% relative humidity or at 15^{o}C and 55 60% relat ve hum dity upto 96 hrs After 4 days of storage the mushrooms lost 12 25% vitamin C with the loss being highest at 15^{o}C and lowest at 5^{o}C

In South India fresh mushrooms are sent to other places by pack ng in polythene bags and these are kept in paper lined bamboo baskets or in corrugated cardboard (Kannaiyan 1989)

Frost and Burton et al (1989) reported a vaccuum cooling system for extending the shelf life of mushrooms which reduces the product temperature rapidly and uniformly

Shelf life of fresh mushrooms is increased in a controlled atmosphere consisting of 9 percent oxygen and 25 percent CO_2 Partial evacuation followed by flushing with carbon monoxide and storage at low temperature can also extend the shelf life upto 20 days Bose et al (1985)

Swinarzki (1989) studied on the preservation of mushrooms by irradiation Mushrooms (Agaricus bisporus) in 0 2 1 8kg containers were irradiated with high energy electrons at 0 8 2 5 KG_y and were stored at 10 18^{o}C for 5 13 days After 6 days mushrooms irradiated at 1 0 and 2 0 KG_y had the highest percentage of closed caps and the best colour Irradiation also reduced the break down of mannitol

Fuster (1990) reported the changes in whole frozen mushrooms during frozen storage The mushrooms were blanched for one minute and packed at atmospheric pressure then subjected to frozen storage at 20^{o}C upto 9 months and its effect on sensory properties composition and enzyme activity were studied and results showed that

blanching reduced enzyme activity and hence browning of thawed mushrooms and high protein contents were maintained throughout storage

Blanched mushrooms can be stored for years in 20 percent salt solution Edible mushrooms are steeped n a solution of 2 5 percent salt 0 1 percent ascorbic acid 0 2 percent sodium bicarbonate and 0 1 percent potassium metabisulphite to give organoleptically acceptable mushrooms with no microbial spoilage upto 10 days storage (Ghatnekar 1983)

Packing of fresh mushrooms in different containers wrapped with PVC films and stored at 3 10 and 20^{o}C improved the shelf life of mushrooms (Manhein 1992) Blanched and unblanched mushrooms were preserved using salt sugar citric acid potassium metabisulphite and ascorbic acid with steeping preservation technique This preservat on technique is economical and simple (Vijaya Sethi and Neeta Behal 1991) Trimming the stipe of cultivated mushrooms from 35 5 millimetre from the cap immediately after harvest resulted in improved shelflife

as ind cated by reduced brown ng and slower cap open ng in the case of button mushroom (Beelman 1992) Another method for preserv ng mushroom s by controlled atmosphere packag ng (Bureau 1993) Under a low O_2 concentrat on with 5 10 percent CO_2 quality of mushrooms were reta ned (Kaj 1993)

The factors affect ng the flavour compound 1 octen 3 01 in mushrooms at harvest and dur ng post harvest storage was reported En∠yme act v ty and 1 octen 3 01 content decreased dur ng storage (Beelman 1993) Refr gerat on is well known to slow the development of mushroom cap and stalks as it retards resp rat on and thereby conserve metabolites wh ch ma nta n cell funct on They are often preserved by can ng freez ng or dehydrat on and can ng is the most common method among these (Turner 1991) A vaccum cool ng system for extend ng the shelf life of mushroom was reported (Frost and Burton 1989) A combinat on of plast c permeable f lm system for control ng post harvest mushroom quality was reported (N cholas 1989) The preservat on of mushrooms by irradiat on had the h ghest percentage of

closed caps and the best colour (Swinarzki 1989) Oyster mushrooms were found fresh under high CO_2 concentration (Henze 1991) Another method of preservation is by preparing sweet chutney from edible mushrooms It had better sensory qualities and good shelf life (Joshi 1992) Methods were studied for the prevention of enzymatic browning in frozen mushrooms after thawing (Fuster 1992) A new process of preservation of mushrooms with reduced weight loss by acid blanching was reported (Malik 1992) Mushrooms are highly perishable and dehydration freezing and canning have been found suitable for preservation provided they are processed with n 2 days after harvest (Pandey 1993) Shelf life of mushrooms can be increased by giving gamma irradiation of 250 Krad dose and storing mushroom at 15^{o}C (Roy and Bahl 1990) Mushrooms were stored in the form of pickles (Sharma 1991)

Experiments conducted by Chatterjee et al (1991) on fried mushrooms showed that sliced mushrooms on being fried to light browning and salted can be preserved like other dried fruits and vegetables Fried and salted

button mushrooms have a pleasant fruity and nutty taste To improve preservability incorporation of upto 2000 ppm SO_2 is permissible under Indian Food Laws Where food laws place lower limits for SO_2 or do no permit its usage thoroughly washed mushrooms could be immersed in salt or sugar solutions of calculated concentrations for some time before frying incorporating the natural preservation

Sharma (1991) reported that mushrooms are good for pickling as other vegetables In India a great number of pickling methods are used Bhatia and Basin (1981) reported that pickles were also made by using fried mushrooms along with vinegar salt sugar and spices condiments and preservatives

Dehydration of mushrooms

Dehydration of mushrooms may be done either in the sun or in mechanical dehydrator and stored in air tight containers or ground and used as mushroom powder (Sethi and Anand 1984) Dehydrated mushroom powders can be mixed with flours for the preparation of chapathi

wafers and other baked products like b scu ts (Ranqaswamy 1993) Dehydrated mushroom powders are stored in a rtight conta ners and can be used for makinq mushroom soups and also as flavour ng agents in otl er foods (Seth1 1993)

Whole or sl ced mushrooms can be sundr ed after treatment with an effective discolouration retardent It is best to dry these mushrooms on a fly proof wire mesh in direct sun sulphurdioxide should be used in perm ss ble concentrations in order to avoid bacterial attack Dried mushrooms should be stored in t ghtly closed containers and a packet of silica gel should be kept in it to keep the mushroms dry Dried mushrooms can be easily rehydrated by boiling in water and this can be used for any recipe Chandra et al (1990) Whole or sliced mushrooms can be dehydrated at 50°C 60°C with a mechanical dehydrator Sulphur dioxide should be used in permissible concentrations in dehydrated mushrooms and they should be stored in tightly closed containers (Aust n 1990)

Although the use of mushroom as food is probably as old as civilization they were earlier preferred only for their flavour and taste while their nutritive value was recognised later (Soh 1986) Information about their food value has been published by various workers at different times The nutritional analysis of 3 edible mushrooms namely Agaricus bisporus pleurotus flabellatus and pleurotus sajor caju was reported by Bano and Sivaprakasam (1986)

Equilibrium moisture content of dehydrated mushroom (Pleurotus Sajor caju) was analysed at five levels of temperature ranging from 10 50°C using static dessicator technique Mould growth was observed at relative humidity greater than 80 percent Pandey (1993) Forty seven volatile compounds contributing to the aroma of cultured edible mushrooms were identified by Morita (1993) The nutritive value of Pleurotus species were evaluated and its biological efficiency of these species were reported to ranged from 12 5 72 4 percent with high protein (Turner 1993)

The protein content of Pleurotus sajor caju was higher than that recorded in other Pleurotus species (Bano 1986) The nutritive value of mushroom can be considered as intermediate between vegetables egg and meat protein (Sivaprakasam 1986) The protein content ranges about 26 72 to 28 47 percent on dry weight basis (Jayarajan 1989) The crude protein content of pleurotus species ranges from 14 4 33 24 percent (Rangaswamy and Mehta 1986 and Suharban 1987) Protein upon fractionation are reported to release albumins globulins prolamines and glutelins (Jayarajan 1989) Thirteen amino acids such as cystine (1 74 mg /100g fresh weight) histidine (2 25mg) lysine (4 77mg) arginine (12 13 mg) methionine (5 56mg) phenyl alanine (5 46mg) and leucine (5mg) and fifteen bound amino acids cystine histidine lysine aspartic acid serine glycine glutamic acid alanine hydroxyproline methionine proline phenylalanine valine isoleucine and leucine were detected (Shanmugham 1986) In Pleurotus tuber regium cystine methionine serine arginine and lysine were low (Nwokolo 1988) The high concentration of

lysine in mushroom protein makes them an ideal food to supplement the cereal diet (Shanmugham and Jayarajan 1989)

The protein content of Pleurotus citrinopileatus was compared with the protein content of traditional oyster mushroom Pleurotus sajor _ caju The amino acid content of both the mushrooms were compared with other mushroom species (Agarwala and Jandaik 1989)

Cultivated Agar cus bisporus contained most of the essential aminoacids with values ranging from methionine 0 40 to lysine 8 percent on dried mushroom Free amino acids constitute 10 percent of a total dried mushroom with protien content of 19 44 percent total nitrogen content 5 64 percent with protein nitrogen 54 2 percent of total nitrogen which is higher than most vegetables (Srinkut 1989)

Investigations by Lintzel (1990) indicate that 100 to 200g of mushrooms (dry weight) are required to maintain nutritional balance in a normal human being weighing 70 kg They equated the nutritive value of mushrooms to that of muscle protein

The mushrooms have a very high food value e twice that of fresh vegetables or half that of lean meat In common with most vegetables mushrooms contain a high proportion of water (Wittingerova 1991) Zakia Bano et al (1976) reported the chemical composition of various species of fresh mushrooms

In general 100g of mushrooms contains 1 2 g of carbohydrates 5 8 gms of protein 0 2 1g of fat 5 15gms of vitamins 0 5 1g of minerals and the caloric value of mushroom is 18 29 kcal/100g Henze et al (1991)

Kalac et al (1989) reported the content of seven b ogenic trace elements in edible fungi Two hundred samples of 19 species belonging to 6 families were analysed for copper manganese zinc iron cadmium chromium and nickel contents The results are tabulated and discussed Very high copper contents were found in Lepiota procera Lepiota rhacodes and Lepiota nuda The iron content of Boletus variegatus has 1160 3 mg/kg DW

Zakhary et al (1990) reported the chemical compostion of wild mushrooms collected from Alexandria

mushrooms The supplementary value of mushroom protein in eqeter an d et is therefore of cons derable significance Ogawa *et al* (1993) reported the quantificaton of free amino acids in the cultivated mushrooms Alanine glutamic acid valine glutamine glycine and leucine were predominant protein amino acids occur ng in the free form

Alar (1990) studied on the nutrit onal valie of the field mushroom *Agar cus campestris* The protein content exceeded that of other vegetables except legumes and the contents of certain minerals such as potassium iron and calcium were high Mushrooms can therefore make an important contribution to human nutrition

Mushrooms contain appreciable amounts of energy value about 30 8 33 6 Kcal (Sivaprakasam 1989) Mushroom has 3 8g percent of complex carbohydrate (Starton 1990) Starch found to be 0 02 0 3 percent (Shanmugham and Jayarajan 1990) The crude fibre content is found to be 0 95 1 10 percent on fresh weight basis and 13 7 15 6 percent on dry weight basis (Kelvin 1991)

According to (Starton 1989) mushrooms have almost no fat The crude fat content is reported to range from 0 25 2 0 percent Mehta et al (1989) The determination of fatty acids of the lipids of mushrooms like Pleurotus ostreatus and Agaricus bisporus was done (Stancher 1992) The free and bound fatty acids were determined in cultivated mushrooms which differed only to a small extent (Jorqy 1993)

Mushrooms are excellent sources of vitamins especially the B complex vitamin riboflavin niacin thiamine pantothenic acid and ascorbic acid vitamin D and vitamin K (Sethi and Anand 1985) The ascorbic acid content ranged from 11 4 47 73 mq /100q fresh weight (Rajarathnam and Bano 1986) The thiamine content was 1 4 to 2 2mg niacin 6 06 7 0 mq riboflavin 6 7 9 0 mg pantothenic ac d 21 2 33 3 mg and folic acid 1 2 1 4 mg /100 gm of dried weight (Bano and Rajaratnam 1988) Niacin wh ch is the most abundant vitamin range from 81mg 135 mg per 100 qm of dried mushroom The time of harvest and method of analysis are reported to affect the amount of niac n (Stroller and Hall 1980)

According to Anderson and Fellers (1982) mushrooms are rich in vitamins especially B complex vitamins In Agaricus bisporus they found 8 6mg ascorbic acid 5 82mg nicotonic acid 2 38mg pantothenic acid 0 12mg thiamine 0 52mg riboflavin and 0 018mg biotin per 100gm fresh weight Mushroom is reported to be an excellent source of riboflavin and nicotonic acid and a good source of pantothenic acid It also contains appreciable amounts of thiamine and folic acid According to Kazeli et al (1984) the vitamin content of pleurotus sp on dry weight basis include thiamine 4 8 mg riboflavin 4 7 mg niacin 108 7 mg

Miller and Grosche (1980) also reported the vitamin contents of Agaricus sp and reported that the retention of these vitamins after canning and stored for 2 months was 78 percent and 85 percent after 6 to 12 months it was 60 70 percent

Among edible mushrooms Agaricus bisporus has the highest sodium content Seegar et al (1985) The magnesium and calcium content ranged from 57 4 106 2 and

from 11 8 162 2 mg per 100 gms of dried mushroom and the sodium and potassium content ranged from 23 8 162 8 and from 2132 to 5809 mg per 100 gms dried mushroom respectively Losato et al (1988) Selinium content ranged from 0 63 to 16 08 mg per Kg dried mushroom Losato et al (1990)

Though it has high cadmium content a large ingestion of Agaricus fungi do not cause toxicity in humans Schellman et al (1992)

The selenium content of various other species of mushrooms were determined Highest selenium contents were in Boletus edulis 17 mg / kg D M Other mushrooms are Lepiota rhacodes(5 6 mg) Lepiota procera(4 8 mg) Wild Agaricus (2 7 mg) Marasmius oreades (1 6 mg) A single meal of Boletus edulis may contain more selenium than the recommended daily intake of 200mg (Zakhary 1993)

Ash analysis given by Anderson and Fellers in 1982 showed that mushrooms contain high amounts of potassium phosphorous copper and iron but the calcium

percentage is quite low The presence of different mineral elements in mushroom increase the food value 100gm of fresh mushrooms contains 3 20mg of calcium 1 5mg of iron 0 1 1 2mg of copper 0 1 0 5mg of zinc 18 70mg of phosphorous and 20 30mg of sulphur Chang and Hayes (1988) reported the mineral content of some of the edible mushrooms of which the calcium content of pleurotus species is 98 mg phosphorus - 476 mg iron 8 5 mg sodium 61mg The mineral composition of pleurotus and Agaricus species were compared (Vetter 1988) The pleurotus species are reported to have lower content of some minerals than the Agaricus species The mineral content of pleurotus sajor caju on dry weight basis was reported by Agarwala and Jandaik (1986) The calcium content being 20 mg phosphorus 760 mg potassium 3260 mg iron 124 0 mg zinc 129 mg copper 12 2 mg and lead 3 2 mg/100 gm

The absence of starch in mushrooms makes it an ideal food for diabetic patients and for persons who wish to remove excess fat from their body Moconell and Esselen (1981) reported that fresh mushrooms contain 0 95

mannitol 0 28 percent reducing sugars 0 59 percent glycogen and 0 91 percent hemicellulose Analysis by Hughes (1982) disclosed that mushrooms are rich in linoleic ac d which is an essential fatty acid There is some evidence that the cream varieties contain more fat than the white varieties Hayes and Haddad (1985) reported that mushrooms are grouped in the category of foods which are low in calories Hence they are recommended in the diets given to heart patients and diabetic patients

There is surprisingly little work published about the volatile part of flavour of mushrooms The researchers are not aware of the enormous strength of the compounds actually responsible for the flavour Hansenn et al (1983) reported that the following compounds such as guanosine 5 monophosphatelenthinonine methyl mercapton hydrogen sulphide aldehyde and acids 1 octen 3 1 pyrazines 7 2 formyl pyroles benzaldehydeoctanol and zocten 1 are associated with the flavour of mushrooms Frost (1989) studied the maintainence and improvement of good flavour in edible mushrooms The distinctive

flavours of edible mushrooms may be affected by various factors during cultivation including the use of chemical treatments the presence of undesirable substances in the substrate the use of chemical fertilizers and indiscr minate use of growth hormones

Medicinal value of Mushrooms

Many fungi today have been used for medical purpose Coprinicus comatus is reputed to exert a hypoglycemic effect which may benefit the treatment of Diabetis mellitus Hayes et al (1988) Mushroom contains low calories but do provide a source of dietary fibre (Dikie 1989) F bre rich foods are helpful for slimming as they act as bulk giving a feeling of fullness and is useful in preventing many non nutritional disorders like constipation diverticulitis and duodenal cancer

The medicinal value of the black mushroom was known since fifteenth century Lentinan extraction is a potential weapon against the dreaded disease AIDS and it reduces the development and spread of polio and herpes viruses reduces the blood presure and strengthens cell

immunity to cancer and decreases the development of certain tumours (Edwards 1990)

Polyporus officinalis was used internally as a universal remedy for all complaints and disorders and applied externally to stop bleeding used for chronic diseases of breast and throat inflamation (Bahl 1991) Some varieties are used for rapid circulation of blood for anasthesia for swollen glands epilepsy heart ailment and rheumatoid arthritis (Sastry 1991)

The significance of tryptophan in mushrooms and its medicinal uses are briefly discussed It is antidepressant dietary additive and pain killer Agaricus b sporus was shown to be especially rich in tryptophar other pleurotus species Coprinus comatus and some other mushrooms was found to be therapeut c materials (Chan 1992) An antitumor active branched (1 3) β D glucon from Volvariella volvacea was extracted and purified (Sone 1992) A rat study on the hypocholestrolaemic activity of mushrooms suggested that feeding of Lentinus edodus reduced the plasmacholestrol (Tanaka 1993) Certain

components contributing to the hypocholestrolaemic action was dreshed in Polyporus mushroom (Sugiyamma 1993) Hypoglycemic actions and antitumoractions of some heteroglycans of ganoderma lucidium are also reported (Sughara 1993)

The most important use of mushroom is as an article of food and its value as condiments of food accessories Mushrooms are among the most appetising table delicacies and add great flavour to food when cooked with them (Purkayastha 1987)

Mushrooms are also utilised for making various articles like hats hand bags picture frames bottle corks curio curry combs ordinary combs flower pots as writing material for dyeing purposes (Neeta Behl 1982)

Materials and Methods

MATERIALS AND METHODS

The study on Nutritional studies on dehydrated oyster mushrooms and their utilization in product development was conducted with the following objectives

(1) To assess the nutritive value in dehydrated oyster mushroom powder

(2) To evaluate the quality of proteins in dehydrated mushroom powder

(3) To develop and standardise an acceptable and nutritious product using mushroom flour as the basic ingredient

(4) To evaluate the shelf life quality of the standardised product

Method of study

(1) Preparation of dehyrated oyster mushroom powder using the method standardised by National Centre for Mushroom Research and Training Solan

(2) Assessing the nutritional quality of the mushroom

powder by analysing the nutrients such as protein fat fiber and minerals

(3) Assessing the nutritional quality of proteins in mushroom powder by animal feeding experiments viz food efficiency ratio protein efficiency ratio digestability coefficient and biological value

(4) Preparation and standardisation of wafers with blends of mushroom powder and black gram flour in various proportions 25 75 35 65 50 50 60 40 and 75 25

(5) Testing the acceptability of the products by organoleptic evaluation

(6) Assessing the shelf life and acceptability of the most acceptable product for a period of one year Wafers are packed and sealed in food grade polypropylene covers and stored at room temperature Shelf life studies and organoleptic evaluation will be conducted every month

1 Preparation of Dehydrated Oyster mushroom powder

Fresh oyster mushroom was purchased and sun dried using the method standardised by National Centre

for Mushroom Research and Training Solan The dried mushroom was finely powdered and the powder was kept in clean dry bottles The bottled powder was preserved in refrigerator

2 Assessing the Nutritional quality of the dehydrated mushroom powder

(a) Nutrient analysis by chemical methods

The nutrients such as protein fat fiber and minerals were analysed in dehydrated mushroom powder The protein content was analysed using the microkjeldahl method (Hawk and Oser 1965) The minerals were estimated using the Atomic Absorption Spectroscopic method (NIN 1983) and the fat and fibre were estimated using the Soxhlet method (NIN 1983)

3 Quality Analysis

A large number of methods have been proposed by various workers for the evaluation of protein quality In the present study animal feeding experiments were conducted to find out food efficiency ratio protein

efficiency ratio digestability coefficient and biological value of dehydrated mushroom proteins Food intake records ga n in body weight and protein intake of the rats were maintained

(3 1) Food efficiency ratio (FER)

A method developed by AOAC (1960) was followed The diets usually contain 10 percent of the protein to be tested and are complete in all other dietary essentials Groups of weanling albino rats were fed for a period of 4 weeks on different diets A group of rats were fed with stock diet and another group of rats were fed w th a d et of dehydrated mushroom powder as protein source (Table 1) The food efficiency ratio was calculated using the following formula

$$\text{FER} \quad \frac{\text{gain in body weight (g)}}{\text{Food in take (g)}}$$

(3 2) Protein efficiency ratio (PER)

The PER was calculated using the following formula

$$\text{PER} \quad \frac{\text{gain in body weight (g)}}{\text{Protein intake (g)}} \quad \text{gain in weight per gram of protein consumed}$$

TABLE I

Composition of diets for animal feeding experiment

Ingredients	Experimental diet (gms)	Stock diet (gms)
Starch	46 gms	57 gms
Skim milk powder		27 gms
Mushroom flour	38 gms	
M neral mixture	5 gms	5 gms
Vitam n mixture	2 gms	2 gms
Ground nut oil	9 gms	9 gms

(3 3) Digestability Coefficient

To find out the digestability coefficient of protein in dehydrated mushroom powder a method developed by Mitchell (1955) was used In this method groups of albino rats (28 days old) were fed successively on protein free d et and diet containing 10 percent protein to be tested for a period of 10 days Records of food intake

were maintained The diet urine and feaces were analysed for nitrogen The digestability coefficient is calculated using the following formula

$$DC \quad \frac{100 \times \text{Nitrogen intake (N in feaces} \quad \text{Endogenous feacal N)}}{\text{Nitrogen intake}}$$

$$\frac{100 \times In \quad (Fn \quad Fe)}{In}$$

(3 4) Biological value

The biological value of protein in dehydrated mushroom powder is calculated using the following formula

$$\text{Biological Value} \quad \{\frac{\text{Nitrogen digested} \quad \text{Nitrogen lost in}}{\text{Nitrogen digested}}\} \times 100$$

$$\{ \quad \frac{\quad}{\text{metabolism}} \quad \}$$

$$In \quad \frac{(Fn \quad Fe) \quad (Un \quad Ue)}{In \quad (Fn \quad Fe)} \times 100$$

In Food nitrogen intake

Fn Feacal nitrogen on diet

Fe Feacal nitrogen on protein free diet

Un Urinary nitrogen on diet

Ue Urinary nitrogen on protein free diet

4 Standardisation of Wafers

Using the dehydrated mushroom powder wafers were prepared in combination with black gram flour in different proportions as indicated in Table 2

Table 2

Different ratios of mushroom flour and black gram flour

Samples	Mushroom flour	Blackgram flour
I	25	75
II	50	50
III	75	25
IV	35	65
V	60	40

Wafers were prepared in all these five proportions by adding salt and chilly powder and the acceptability of the products were tested by organoleptic evaluation the chemical score and cost benefit ratio of each proportion were calculated

(4 1) Selection of Judges for scoring

The panel members for acceptability trials at the laboratory level were selected from a group of fourty members Triangle Test (Jellinek 1964) was employed to select the panel members In the triangle test three sets of sugar solution of different concentration were used Of the three sets two solutions were of identical concentrat on and the subjects were asked to identify the third sample which is of different concentration Thus from fourty persons who participated in triangle test fifteen persons were selected as judges for the present study A score card was developed for the study wh ch is shown in Appendix I The major quality attributes included in the score card were appearence flavour texture taste overall acceptability at a five point hedonic scale Each of the above mentioned quality is assessed by a five point rating scale This is shown in Appendix II

(4 2) Preparation of Wafers

The requ red amount of mushroom powder and

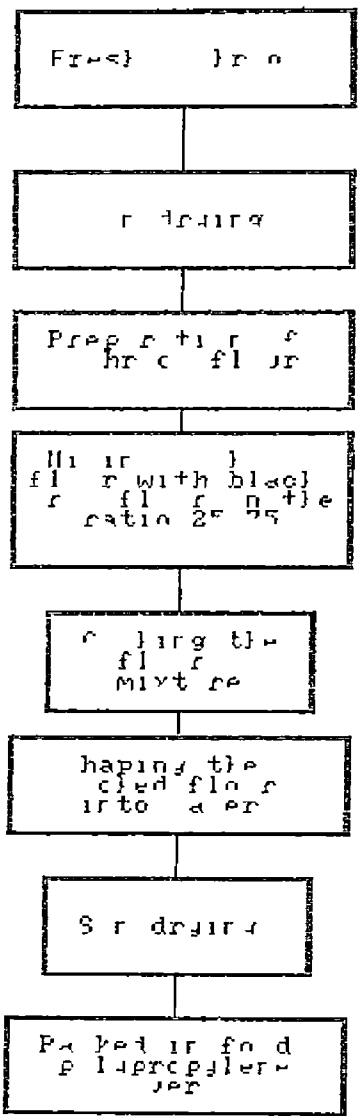
black gram flour was taken in the proportions as indicated in Table 2 and ingredients like salt chillie powder pepper powder and cumin seeds were added to improve the taste and flavour Required amount of water is added and cooked by continuous stirring till it leaves the sides of the vessel Then they were made into lime size balls pressed into thin wafers and sundried When dried they were packed and sealed in polypropylene covers(250 guage) A flow chart showing the steps in the preparation of wafers is presented

(4 3) Scoring the wafers

The judges were requested to taste one sample at a time inorder to score it They are requested to taste the second sample after washing their mouths Each quality was assessed by the panel members after tasting the same sample several times The panel members were permitted to take their own time to judge the samples leisurely The testing was conducted between 3pm and 4pm since this time is considered as the ideal time for conducting the acceptability studies (Swaminathan 1974)

Fl } rt }n r g the ter the rep ratio f

M hr rn fers



The panel members were requested to give scoring based on two sets of responses the first giving perference rank and the second an assessment of sensory qualities

Statistical analysis was done in order to find out the most acceptable product among the different proportions Simple analysis was done in order to find out the most acceptable product among the different proportions

5 Microbial analysis

The incidence of microflora was tested n stale mushroom wafers Potato dextrose agar was prepared for funqus Maltose dextrose agar for yeast and nutrient agar for bacteria Direct plating method was done for fungus and bacteria and serial dilution method for yeast

Result and Discussions

RESULTS AND DISCUSSION

The results of the present investigation entitled Nutritional studies on dehydrated oyster mushrooms and their utilization in product development is discussed under the following headings

4.1 Nutritional study of dehydrated mushroom powder

4.2 Evaluation of protein quality

4.3 Product development

4.4 Shelf life study of the standardised product

4.5 Incidence of pests and microflora

4.6 Cost benefit ratio of the product

4.1 Nutritional study of dehydrated oyster mushroom powder

Dehydrated oyster mushroom powder was analysed for protein moisture fibre fat and minerals

The results obtained is presented in Table 3 The percentage of protein in *Pleurotus sajor caju* on dry

we ght basıs reported by Sasthrı (1991) ranged between 15 34 percent In the present ınvestıgatıon the protein content was ın the range of 26 72 28 47 percent on dry we ght basıs The crude protein content of pleurotus species was reported to be ın the ranges of 14 4 32 24 percent (Rangaswamy and Mehta 1986)

The moısture content of Pleurotus Species reported by Patel (1991) was 80 percent ın fresh mushroom In the moısture analysıs the value obtaıned ıs 12 9 percent on dry weight basıs The moısture content on dry weight basıs reported by Pathak (1990) was 10 13 percent

The fıbre content of oyster mushroom on dry weight basıs reported by Pathak et al (1989) was 12 0 16 5 percent In the present ınvestigatıon the fıbre value obtaıned ıs 13 percent The fıbre content reported by Kelv n (1991) ranges between 13 7 15 6 percent on dry weight basıs Mushrooms are reported to provide a good source of dietary fıbre (Dıkkıe 1989)

Mushrooms are negligible sources of fat(Starton 1989) The determination of fatty acids of the lipids in mushrooms was done by Stancher in 1992 The free and bound fatty acids were determined in cultivated mushrooms which differed only to a small extent ranging from 0 1 2 0 percent In the present investigation the fat content in dehydrated mushroom powder was found to be 0 2 percent

Mushrooms are good sources of minerals Losato (et al 1990) The mineral content of mushroom of pleurotus species on dry weight basis reported by Agarwala and Jandaik (1986) is calcium 140 mg/100 gm phosphorus 760 mg Potassium 3260 mg Iron 124 Omg and Zinc 1290 mg Mushrooms are high in mineral content potassium and phosphorous being the main constituents where as sodium calcium magnesium copper and iron are present in relatively fair amounts (Losato 1991) In the present nvestigation the mineral content obtained s calcium 1 6 gms 0 12 gms of iron 3 25 gms of potassium and 0 125 gms of zinc (Table 3)

TABLE 3

Nutrient content of dehydrated oyster mushroom powder

Nutrients	g/100gms
Protein	31 15
Fat	0 2
Fibre	13
Moisture	12 9 percent
M nerals	
Calcium	1 6
Iron	0 12
Pottassium	3 25
Zinc	0 125

The values obtained in this investigation is comparable with the early research reports In the present investigat on the estimated values for protein fat fibre and m nerals in dehydrated mushroom powder are well comparable with earlier studies

Mushroom protein is considered as an intermediate between egg and meat protein Sivaprakasan et al (1986) The values obtained in the present investigation is compared with the nutritive values of egg and meat The results are shown in Table 4

TABLE 4

Comparison of nutritive value of mushroom powder with egg a meat _ g/100gm

Food Item	Protein (gms)	Fat (gms)	Calcium (gms)	Iron (gms)	Phosphorus (gms)	Potassium (gms)
Mushroom Powder (Pleurotus)	31 15	0 2	1 6	0 12	0 76	3 25
Egg	13 3	13 3	0 06	0 002	0 22	
Meat (goat)	21 4	13 6	0 012		0 193	

The protein content of pleurotus sajor caju was found to be higher than egg and meat protein The

minerals like calcium iron phosphorous and potassium were found to be higher in mushrooms than egg and meat The fat content of mushroom was very much less when compared with egg and meat From this comparison it is evident that mushrooms are highly nutritious and it can be included in diets of diabetic patients since it s fat content and calorie content are negligible

4 2 Evaluation of Protein quality

Ritchey and Taper (1981) reported that the most realistic way to assess the nutritional quality of proteins is through feeding trials Several biological measurements have been proposed as indicators viz Protein Efficiency Ratio (PER) Food Efficiency Ratio (FER) and nitrogen balance studies From these several indices of protein quality namely true digestability coefficient and biological value were worked out

Swaminathan (1989) has also reported that quantitative data regarding the relative digestability coefficient and nutritive value of proteins ie

su tab l ty to meet the protein requ rements of the body can be obta ned only through experiments on animals or human beings Three methods ie Protein Efficiency Rat o (PER) Net Protein Ratio (NPR) and Net Protein Utilization (NPU) have been w dely used as the most suitable methods for the evaluation of quality dietary proteins Satinder et al (1991) conducted nutritional evaluation of Agaricus bisporus using albino rats In his study feeding of mushroom diet resulted in an increased food intake without any food efficiency ratio or Protein efficiency ratio values

4 2 1 Food Efficiency Ratio (FER)

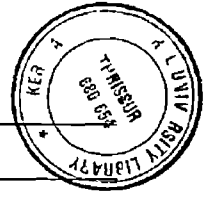
In the present invest gation animal feeding experiments were conducted to evaluate mushroom prote n The results of FER stud/ to evaluate mushroom protein is given below in Table 5 To find out the significant difference between experimental and control group t test was done The results showed that there is significant difference between experimental and control group at 5 percent level

TABLE 5

Evaluation of mushroom protein by FER study

Weeks	Experimental Group			Control Group			tvalue
	Average food in take(gms)	Average weight (gms)	Average weight gain per week(gms)	Average food in take(gms)	Average weight (gms)	Average weight gain per week(gms)	
Initial Weight		70 5	-	-	68 5	-	435**
End of I st Week	70 7	73 2	2 7	70 0	71 2	2 7	
End of II nd Week	68 5	76 4	3 2	71 7	77 2	6 0	
End of III rd Week	66 0	86 2	9 8	74 2	93 2	16 0	
End of IV th Week	69 0	95 2	9 0	75 0	101 2	8 0	
Average weight gain in one month			24 7		32 7		
Food Efficiency Ratio			36 2 percent		44 9 percent		

** Significant at 1 percent level



The gain in body weight of experimental group in 4 weeks was 24 7 gms and the gain in body weight of control group was 32 7 gms The food intake of experimental group in the first week was higher when compared with the control group but in the rest of the weeks the food intake was found higher in the control group From the data obtained (Table 5) the Food Efficiency ratio of both the experimental and control group was calculated The food efficiency ratio of the rats which were given the mushroom flour as the protein source is 36 2 percent and that of control group is 44 9 percent From the present study it is evident that there is an association between gain in weight and food intake The food intake of the rats which were given the mushroom diet were less when compared with the rats which were given milkpowder

4 2 2 Protein Efficiency Ratio (PER)

Edjer et al (1991) studied on the protein quality of oyster mushroom (Pleurotus sp) A study was

carried out to determine the nitrogen and protein content of oyster mushroom powder The total nitrogen content was 3 4 percent in dry matter 5 8 percent free amino acids 47 7 percent protein and the remainder by other nitrogenous substances The protein was comparable to animal protein

The protein intake of experimental group fed with mushroom powder was higher when compared with the control group but in the rest of the weeks the protein intake was found higher in the control group The gain in body weight of experimental group in four weeks was 24 7 gms and the gain in body weight of control group was 32 7 gms The results of PER study is shown in Table 6

The statistical analysis using t test was done to find out the significant difference between experimental and control group The results showed that there is signif cant difference between control and experimental group at 5 percent level

TABLE 6

Evaluation of Mushroom protein by PER study

Weeks	Experimental group Average protein intake(gms)	Average weight (gms)	Average weight gain per week	Control Group Average protein in take (gms)	Average weight (gms)	Average weight gain per week	tvalue
Intal weight		70 5	-		68 5		
End of I st Week	10 6	73 2	2 7	9 3	71 2	2 7	14**
End of II nd Week	9 4	76 4	3 2	9 6	77 2	6 0	
End of III rd Week	8 7	86 2	9 8	9 9	93 2	16 0	
End of IV th Week	9 1	95 2	9 0	10	101 2	8 0	
Average weight gain in one month		24 7			32 7		
Protein efficiency Ratio		2 6%			3 3%		

**Significant at 1 percent level

The PER of the experimental group was 2 6 percent and that of the control group was 3 3 percent The gain in body weight in 4 weeks was found to be higher in the control group which was given the milk protein than the rats given mushroom powder as the protein source

TABLE 7

Biological Value (B V) of Mushroom protein

SL NO	GROUP	B V	tvalue
1	Experimental group	80 percent	380**
2	Control group	87 6 percent	

** Significant at 1 percent level

4 2 3 Biological Value (B V)

Osberne (1964) developed a method for determining the biological value of proteins The

biological value of mushroom as well as milk powder were tested in groups of 28 days old albino rats The results showed that the biological value of the control group were significantly different from experimental group at 5 percent level (Table 7)

TABLE 8

Digestability coefficient (D C) of Mushroom protein

SL NO	GROUP	D C	tvalue
1	Experimental group	90 percent	140**
2	Control group	92 8 percent	

** Significant at 1 percent level

In dried mushroom the total nitrogen content ranges between 5 0 5 64 percent Srinkut et al (1987) In the present study the nitrogen content of mushroom

prote n obtained was 5 0 percent The b olog cal value of m1lk protein was h gher when compared to the mushroom prote n The b ological value of mushroom protein obta ned was 80 percent whereas the biological value of m1lk protein was 87 6 percent The percentage of nitrogen excreted though feaces was higher when protein food was given in both experimental and control groups The percentage of n trogen excreted through feaces was higher than those excreted through urine in both the groups The percentage of protein in mushroom s very much higher than most vegetable protein (Shanmugham 1989)

4 2 4 Digestability coefficient (DC)

The d gestability coeff cient was calculated in rats which were given the mushroom protein and m1lk protein Pathak(1986) have reported that mushroom proteins have high digestability In the present study the digestab lity coefficient was found higher in m1lk protein than mushroom protein The digestability coefficient of mushroom protein obtained was 90 percent and that of m1lk prote n was 92 8 percent The results

showed that there is significant difference between experimental and control group at 5 percent level (Table 8) Even though it has been reported that mushroom protein is easily digestable the digestability is not as high as milk protein In earlier studies it has been reported that mushroom protein is an intermediate between vegetable and egg protein and has high digestability (Sivaprakasan 1986) Lintzel (1984) reported the digestability of proteins as 72 93 percent

4 3 Product development

Oyster mushrooms were selected for product development because they are better in consumer aspects with a larger shelf life (Sohi 1986) Wafers were prepared with different combinations of mushroom flour and blackgram flour and the chemical scores of these ratios were calculated and presented on Table 9

The amino acid contents were worked out using the food composition tables of ICMR (1982) Using these values chemical scores were found out from the ratio

between the content of the most limiting amino acid in the test protein to the content of the same amino acid in egg protein expressed in percentage All the five combinations had chemical scores above 80 percent

TABLE 9

Chemical Scores obtained for Mushroom wafers

SL NO	Ingredients (in percentage) Mushroom flour	Blackgram flour	Chemical score
1	25	75	83 3
2	50	50	88 8
3	35	65	85 5
4	60	40	91 1
5	75	25	94 4

The wafers were prepared and were subjected to organoleptic evaluation among selected judges The score card was prepared on a five point hedonic scale The

major quality atributes included were appearance flavour taste texture and overall acceptability (Appendix II) The scores given by the judges were subjected to statistical analysis

Statistical analysis of the mean scores obtained for different ratios of mushroom wafers with respect to its quality attributes v z taste flavour appearence texture and overall acceptability (Table 10) revealed that in the case of taste and flavour attributes the scores obtained ranged between 1 33 to 4 73 The highest score of 4 73 was obtained by the ratio 25 75 and the lowest of 1 33 to the ratio 75 25 Comparision with CD value showed that there was significant difference between the ratio 25 75 with all the other ratios Table10 also revealed that the difference between the ratios 50 50 and 35 65 as well as 60 40 and 75 25 was negligible There was also a significant difference between the ratio 50 50 with that of the ratio 60 40 and 75 25

In apearence all the ratios 25 75 50 50 35 65 60 40 and 75 25 showed significant difference with

Table 10

Mean values obtained for the acceptability test of mushroom wafers

Sl No	Different combinations of		Quality parameters				
			Taste	Flavour	Appearance	Texture	Overall acceptability
	Mushroom	Blackgram flour					
1	25	75	4 73	4 6	4 53	5 0	4 8
2	50	50	3 2	3 26	3 26	4 06	3 6
3	35	65	2 93	3 46	2 66	2 86	2 73
4	60	40	1 66	1 93	1 93	2 2	1 86
5	75	25	1 33	1 53	1 33	1 46	1 26
	CD Values		0 635	0 598	0 464	0 646	0 458

each other The scores ranged between 4 53 to 1 33 The h ghest score obtained by the ratio 25 75 and the lowest was to the ratio 75 25 The second highest score of 3 26 was attained by the ratio 50 50 The difference between the ratios 60 40 and 75 25 were found negligible In texture the lowest score was for the ratio 75 25 and the highest of 5 0 for the ratio 25 75 The second highest score (4 06) was obta ned by the ratio 50 50 There was significant difference between all the ratios

W th regard to overall acceptability aga n the highest score (4 8) was for the ratio 25 75 The scores ranged from 4 8 to 1 26 The lowest score of 1 26 for the ratio 75 25 The ratio 50 50 had the second highest score of 3 6 The ratios 35 65 and 60 40 had the scores of 2 73 and 1 86 respectively All the ratios were found significantly different among each other Since the atio 25 75 scored maximum in quality attributes a suitable product with 25 percent mushroom flour and 75 percent blackgram flour was prepared for shelf life study

The nutritive value of the combination of wafers with mushroom flour and blackgram flour was computed from Nutritive value of foods ICMR (1982) The results revealed (Table 11) that the 100 gms of mushroom wafers contain 25 8 gm of protein 45 6 gm of carbohydrate and provides 268 4 k cals of energy This product also provides relatively higher amounts of minerals and vitamins The fat content is very negligible

4 4 Shelf life study of the standardised product

The wafers in the proportion 25 75 were prepared and stored in polypropylene covers and kept at room temperature for shelf life study for a period of one year The product maintained its quality upto five months Each month the wafers were subjected to organoleptic evaluation by the selected panel of judges The scores obtained were subjected to statistical analysis (Table 12) Simple Anova method with 15 replictions was done

As per the table(12) in the first month of the sensory evaluation test the wafers scored highest in all

TABLE 11

Nutritive value of mushroom wafers made with mushroom flour and blackgram flour in the proportion of 25 75

I m	Protein (gms)	Fat (gms)	Carbohydrate (gms)	Energy (Kcal)	Calcium (gms)	Phosphorous (mg)	Iron (mg)	Thiam ne (mg)	Riboflavin (mg)	N acin (mg)
Mushroom flour(25g)	7 8	0 05	0 95	8 4	5 0	190	31	0 55	2 25	1 51
Black gram flour(75g)	18	1 05	44 7	260	115 5	288 7	6 8	0 31	0 15	1 5
Total	25 8	1 1	45 6	268 4	120 5	478 7	37 8	0 86	2 4	3 01

the qual ty attrıbutes vız taste flavour appearence texture a d overall acceptabılıty Wıth the scores of 1 8 4 86 4 73 5 0 and 4 86 respectıvely whereas ın the second month a slıght degradat on ın the organolept c scores was found and the scores were 4 26 4 66 4 33 4 46 and 4 4 respectıvely The flavour scored maxımum among the quality attrıbutes Sımılarly ın the thırd fourth and fıfth month of storage perıods also ıt was found that the scores for dıfferent quality attrıbutes were decreased

In the thırd month the mean scores of the quality attrıbutes were 4 13 4 2 3 93 4 0 and 3 93 respectıvely The mean score for taste slıghtly decreased when compared wıth fırst two months but ıt scored hıgher among other quality attrıbutes ın the thırd month Appearence and overall acceptabılıty were decreased when compared wıth the fırst two months Appearence and overall acceptabılıty had least scores among the quality attrıbutes

In the fourth month there was a consıderable

TABLE 12

Mean scores obtained for the wafers stored at different storage periods

Storage period	Quality Parameters Taste	Flavour	Appearence	Texture	Overall acceptability
1st month	4 8	4 86	4 73	5 0	4 86
2nd month	4 26	4 66	4 33	4 46	4 4
3rd month	4 13	4 2	3 93	4 0	3 93
4th month	3 66	3 86	3 73	3 6	3 2
5th month	2 73	3 2	3 06	3 06	2 4
CD Value	0 403	0 321	0 381	0 329	0 392

decrease in the mean scores when compared with the first three months The mean scores of the quality attributes where 3 66 3 86 3 73 3 6 and 3 2 respectively There was a considerable decrease in the case of taste flavour and overall acceptability when compared with the other three months

In the fifth month the mean scores of the quality attributes were decreased and the scores were 2 73 for taste 3 2 for flavour 3 06 for appearence 3 06 for texture and 2 4 for overall acceptability The mean scores of taste and overall acceptability were very low when compared with other months

Comparision with CD values showed that there was significant difference between almost all the scores of every quality attributes in each month The exception is for taste flavour and appearence In taste there was not much significant difference between the scores in the second month (4 26) and third month (4 13) In flavour there found a significant difference in the first (4 86) and second month (4 06) In appearence the scores in the

th rd (3 93) and fourth month (3 73) did not show a significant difference After five months the wafers started deteriorating and then they were subjected to examine microbial contamination

Rathnam et al (1993) has reported that dehyd ated mushroom powders and their products like wafers and baked biscuits if stored in air tight conta ners can be preserved for 6 8 months

4 5 Incidence of pests and microflora

The mushroom wafers stored in polypropylene covers maintained its quality upto f ve months They were tested for microbial contaminations in each month

The mould growth was observed at relative humidity greater than 80 percent in fresh mushrooms (Pandey 1993) In the fifth month microbes were analysed from the stored products The results revealed that fungus growth was observed in the products The species identif ed as Aspergillus niger No other micro organisms like bacteria or yeasts were detected

Pest incidence were also not found either in the polypropylene covers or in the stored products

4 6 The cost benefit ratio of the product

Many mushroom products are now available in the market but they are easily perishable with a short shelf life Mushroom pickles are available in the market but their shelf life extends only upto one or two months at room temperature Dehydrated mushroom products like mushroom soup powder are available in the market (Journal of Food Science 1993) But these soups powders are costly and so these are being purchased only by high income groups in the society A survey on mushroom consumption in Coimbatore by Avinashlingam University (1989) proved that cost was the main factor hindering the consumption of mushroom in the low income group The cost benefit ratio including 10 per cent overhead charges of the mushroom wafers were calculated and is presented along with the nutritive value of major ingredients in the mushroom wafers and other snacks available in the market which is frequently used by the people were computed from Nutritive value of Indian foods ICMR (1982) The price given for common snacks were the market price

TABLE 13

Comparison between the cost and nutritive value of mushroom wafers and other Snacks

Item	Cost 100 g product	Protein (gms)	Energy (Kcal)	Fat (gms)	Carbohydrate (gms)	Calcium (mg)	Phosphorous (mg)	Iron (mg)	Thiam ne (mg)	Riboflavin (mg)	Niac (m
Mushroom wafers	Rs 1[illegible] 50	25 8	268 4	1 1	45 6	120 5	478 7	37 8	0 86	2 4	3 0
Potato Chips	Rs 7 00	1 6	97 0	0 1	22 6	10	40	0 7	0 10	0 01	1
Banana Ch ps	Rs 10 00	1 2	116	0 3	27 2	17	36	0 9	0 05	0 08	0
Bread	Rs 5 50	7 8	245	0 7	51 9		11	1 1	0 07		0
Biscu ts	Ps 6 50	6 4	450	15 2	71 9						

From table 13 it is evident that mushroom wafers were rich in almost all nutrients The high concentration of lysine in mushroom protein makes them an ideal food to supplement the cereal diet (Shanmugham 1986) Mushrooms are highly nutritious having greater palatability and shelf life (Shanmugham 1989) When the cost of mushroom wafers were compared with other snacks mushroom wafer costs more but with regard to nutritive value the validity was much higher in the case of mushroom wafers The mushroom wafer in the proportion 25 75 was found suitable for product development and since it scored maximum in organoleptic evaluation and has good shelf life and nutritive value this product can be produced in large scale so as to reduce the protein malnutrition and also as a solution to unemployment especially among women folk

Summary

SUMMARY

Mushroom cultivation is the most efficient and economically viable biotechnology process for the conversion of lignocellulose waste materials into high quality protein food The world wide demand of cultivated mushroom at present is about 3 5 million tonnes valued Rs 12 000 crores It is becoming a popular item among the people due to its availability and its innate flavour and taste The short shelf life of commonly grown mushrooms poses a big problem for mushroom growers It is in this context arises the need for developing products with mushrooms with high acceptability and shelf life qualities Hence this study entitled Nutritional studies on dehydrated oyster mushrooms and their utilization in product developement was taken

Nutrient analysis of dehydrated oyster mushroom powder was done by chemical analysis The proximate constituents like protein moisture fibre fat and minerals were analysed The percentage of protein in dehydrated oyster mushroom powder was higher The

moisture content was negligible The fat content was negligible and the fibre content was comparatively high

The mineral like calcium potassium iron and zinc were tested The potassium content was present in high amount than other minerals Other minerals like calcium iron and zinc were present in fair amounts

An evaluation of protein quality was done by animal feeding experiments The mushroom powder was fed among twenty eight days old albino rats and the mushroom protein were compared with the milk protein The food efficiency ratio and protein efficiency ratio was higher in milk protein than mushroom protein This is because the intake of mushroom flour by the rats were comparatively less when compared with the rats which were fed with milk powder The biological value and digestability coefficient was found higher in rats fed with milk powder as the protein source Although it has been proved that mushroom protein is highly digestable their digestability is less when compared with milk protein

Inorder to make a suitable mushroom flour product with a longer shelf life a combination with mushroom flour and blackgram flour was used to prepare mushroom wafers Initially the mushrooms were dried under sun and then powdered and stored in air tight containers and then these dehydrated mushroom flours was mixed in different proportions with blackgram flour The var ous proportions are 25 75 50 50 35 65 60 40 and 75 25 The wafers were prepared in all these proportions and subjected to organoleptic evaluation among a panel of judges These scores were statiscally analysed and the results revealed that majority of the judges liked the wafers prepared with 25 percent mushroom flour and 75 percent blackgram flour The wafers were prepared in this proportion and packed in polypropylene covers and stored for one year The wafers were stored at room temperature for shelf life study

Each month the wafers were subjected to organoleptic evaluation among a panel of judges The wafers scored highest in their quality attributes in the

first month In later months their quality attributes slightly decreased When the wafers started deteriorating with a foul smell they were subjected to examine microbial contamination and incidence of pests The pest attack was not found but fungal attack was found in the wafers Yeast and bacterial attack was absent The fungi found in the wafers were examined under a microscope and it was found to be Aspergillus niger

The cost benefit ratio of the mushroom wafers was calculated and compared with other packaged foods now available in the market The cost of mushroom wafers was almost similar with other packaged foods The nutritional quality was found to be higher in the mushroom wafers than other snack foods available in the market

Any mushroom product with a longer shelf life of produced will have more demand in the society The protein malnutrition commonly prevalent among low income group can be removed to a certain extent by cultivating and producing more nutritionally rich mushroom products which is cheaper and having a longer shelf life Protein

gap in developing countries has necessiated the search for alternative sources of protein In the past many novel sources of protein were tr ed and rejected due to unpalatability and consumer reistance Any new food item should not only be nutritious but should also enjoy consumer preference

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Appendix

APPENDIX I

Evaluation Card for the triangle test

Name of the product Sugar solution

Note

Two of the 3 samples are identical Identify the odd sample

Serial No	Code No of sample	Code No of identical samples	Code No of odd samples

APPENDIX II

Score card for acceptability test of food products

Quality attributes	Sub d vision of attributes	Score for each s b division attributes	Score for sampl samples Code No 1 2 3 4 5
Appearence	Very poor	1	
	Poor	2	
	Fair	3	
	Good	4	
	Very good	5	
Flavour (Aroma)	Dislike	1	
	Neither like nor dislike	2	
	Like slightly	3	
	Like moderately	4	
	Like very much	5	
Texture	Soggy	1	
	Rubbery	2	
	Very hard	3	
	Hard	4	
	Crisp	5	
Taste	Poor	1	
	Fair	2	
	Very fair	3	
	Good	4	
	Very good	5	
Over all acceptability	Unacceptable	1	
	Neither acceptable nor unacceptable	2	
	Slightly acceptable	3	
	Acceptable	4	
	Highly acceptable	5	

Abstract

NUTRITIONAL STUDIES ON DEHYDRATED OYSTER MUSHROOMS AND THEIR UTILIZATION IN PRODUCT DEVELOPMENT

by

Hema.V.

ABSTRACT OF THE THESIS

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ABSTRACT

Mushrooms are becoming a popular item among the people due to its availability and its innate flavour and taste But mushrooms are easily perishable with a short shelf life A study entitled Nutritional studies on dehydrated oyster mushrooms and their utilization in product development was taken up with the aim to develop a nutritious mushroom product with a longer shelf life

A nutrient analysis of dehydrated mushroom powder was done by chemical analysis The nutrient analysis for protein revealed that pleurotus species are rich in protein content The moisture content is negligible in dehydrated mushroom The fibre is comparatively high compared to fat content in pleurotus species The minerals like calcium potassium iron and zinc were tested The potassium content is present in high amount when compared with other minerals In order to analyse the quality of protein animal feeding experiments were done The food efficiency ratio protein efficiency ratio biological value and digestability

coefficient was found out Statistical analysis revealed that the experimental group were significantly different from control group

Mushroom wafers with dehydrated mushroom flour in combination with blackgram flour was prepared The mushroom flour was mixed with blackgram flour in the proportions 25 75 50 50 35 65 60 40 and 75 25 The wafers were prepared in all these proportions and subjected to organoleptic evaluation among a panel of judges These scores were statistically analysed and the results revealed that majority of judges liked the wafers prepared with 25 percent mushroom flour and 75 percent blackgram flour The wafers were prepared in this proportion and packed in polypropylene covers for a one year storage study The wafers maintained its quality for five months Each month the wafers were subjected to organoleptic evaluation When the wafers started deteriorating with a foul smell they were subjected to exam ne the incidence of pests and microflora Only fungal attack was found and it was found to be Aspergillus niger The scores obtained during each month was

statistically analysed The results revealed that the wafers scored maximum in their quality attributes during first month and in later months the scores lowered accordingly The cost benefit ratio of the mushroom wafers were compared with other packaged foods like chips available in the market The cost of mushroom wafers were slightly higher than packed foods but they were rich in nutrients than packed foods like banana or potato chips

The products developed from dehydrated oyster mushroom flour is highly nutritious acceptable and has got a good storage quality and a reasonable price So mushroom growers can take it up as an income generating and profitable business when there is excess production of fresh mushrooms