

**OPTIMIZATION AND FORMULATION OF
NUTRI-RICH SNACK FOOD (SEV)**

THESIS

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

**In partial fulfilment of the requirement for
the Degree of**

MASTER OF SCIENCE

In

**AGRICULTURE
(FOOD TECHNOLOGY)**

By

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*This is to certify that the thesis entitled “**Optimization and formulation of nutri-rich snack food (sev)**” submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (Ag). In Food Technology** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by **Mr.Surendra Kumar Patel** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instruction.*

All the assistance and help received during the course of investigation has been duly acknowledged by him.

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Date:

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IST OF ABBREVIATIONS

%	-	Percent
i.e.	-	that is
Mg	-	Milligram
Cm	-	Centimeter
G	-	Gram
NS	-	Non significant
CD	-	Critical difference
LDPE	-	Low density polyethylene
et al.	-	co-workers
w/v	-	weight/volume
°C	-	degree centigrade
hr.	-	Hour
Min	-	Minute
ml.	-	Milliliter
SEm±	-	Standard error of mean
Approx	-	Approximately
Fig.	-	Figure

INTRODUCTION

Snacks foods represent a large group of food product prevalent in the world market. A variety of snack foods are common in Indian market as well the snacks are convenient foods to satisfy the short term hunger (Tettweiler, 1991). As people have tended away from the conventional three meals a day due to various season, they have began consuming many mini meals. Snacks are sometimes called continuous fourth or fifth meals and are even between the main meals (Hauck, 1980). As a variety of snack foods are available in today's market, it is difficult to categorize them, although in broad sense it can be categorized as sweet as savory, light and substantial. They may be enclosed with attributes such as healthy or just for fun. Thus snack foods make a significant part of food industries (Tettweiler, 1991).

Fried snacks are such class of foods in which deep fat frying is widely practiced. Deep fat frying is used to impart cooking, enrich, contribute energy and after a mouth feel to finished product. The energy content increases due to a tremendous increase in the fat content of product. "Sev" is one of the popular Indian traditional deep fat fried snack food (Pruthi et al; 1983). Traditionally, it is prepared from Bengalgram flour (besan) with additives such as salt, spices and sodium bi carbonate; various other additives are also added to impart crispy and crunchy texture organoleptic appeal and to increase physical condition of the fried product (Berry et al; 1986). Demand and consumption of snack food is increasing day by day consequently there is a need to increase production of more nutritious and cost effective snacks.

Sev is a popular Indian snack food. It is available in small pieces of crunchy noodles made from chickpea flour paste which is seasoned with turmeric and chilli powder and deep-fried in oil. These noodles vary in thickness. Ready-to-eat varieties of sev, including flavored sev are available in Indian stores. Sev is eaten as a standalone snack as well as a topping on dishes like bhelpuri and sevpuri. This popular snack being tasty and tempting is simultaneously full of fats as it is deep fried. To enhance the taste, the flour is seasoned with chilli powder, turmeric, sesame seeds and carom seeds. Sev is essentially small pieces of crunchy noodles. Sev is a popular variety of Indian snack food. Sev can be made with whole bengal gram flour and rice flour mix at home and stored for weeks in airtight containers. Sev is a popular

extruded, fried snack in India made from chickpea (*Cicer arietinum L.*) flour dough containing pepper, cumin, ajwain as a flavorant (optional) and is relished for its texture and aroma.

Millets are nutritionally superior to other cereals. The millet contains a high proportion of complex carbohydrate and dietary fiber which helps in prevention of constipation and slow release of glucose to the blood stream. Millets are rich in B vitamins, especially niacin, B6 and folic acid as well as Calcium, Iron, Potassium, Magnesium and Zinc.

Minor millets are claimed to be future foods for better health and nutrition security in the recent years, they are recognized as important substitutes for major cereal crops to cope up with the world food shortage and to meet the demands of increasing population (Rachie, 1975). Minor millets like kodo and kutki are described as nutritious millets and have received far less research. Millets are rich in vitamins, minerals, sulphur – containing amino acids and phytochemicals, and hence are termed as nutri – cereals.

Kodo millet (*Paspalum scrobiculatum*) is one of the hardiest crops grown in Madhya Pradesh, Maharashtra, and Uttar Pradesh and various other parts of India. Minor millets like kodo is also described as nutritious millet and has received far less research and development attention than other crops with regard to crop improvement and utilization. According to Directorate of Millets Development, kodo millet is grown in area of about 907,800 ha with annual production of about 310,710 tonnes. It is the main source of protein and minerals in the daily diets of tribal and weaker section living in remote rural areas. Millets are nutritionally superior to other cereals. The millet contains a high proportion of complex carbohydrate and dietary fiber which helps in prevention of constipation and slow release of glucose to the blood stream. Kodo contain water soluble fiber and this property may be utilized for maintaining or lowering blood glucose response among diabetic and CVD (cardio vascular disease) patients.

Soya bean (*Glycine max L.*) is the most popular oilseed in the country after groundnut and soy meal is the largest produced oil meal in the country. India produces 5-7 million tonnes of beans, 1 million tonnes of oil and 3-5 million tonnes of soy meal in a normal year. M.P. (3.5-4.5 million tonnes) is the major producer of soybean in India. Soybean is a source of good quality (40%) protein and (20%) oil. It has double protein compared to other pulses.

Soybean is associated with anti nutritional factor such as trypsin inhibitors and ham agglutinins in addition to other. Heat treatment inactivates anti nutritional factor such as, trypsin inhibitors and ham agglutinins (Singh et al. 1994).

Sev is an established snack food in various part of our country, high cost of raw material i.e. Bengal gram flour contributes towards final cost of the furnished product which limits it's marketing. To overcome this limitation, bengal gram flour can be replaced by flour of cheaper legumes, cereals and millets to the extent that the final product is maintained. Seeing the above innumerable plus point of the crop and the exorbitant prices of the other edible legume flour for it has become the most suitable legume flour for the partial replacement of besan for the "sev" preparation.

Deep fat frying is one of the most commonly used procedure, both in the food industry and household culinary practices. The fat serves as a heat transfer medium and as an important ingredient of the fried food. In India also in whole of the world's diet, the deep fried foods are one of the major items. Major portion of edible oils and fats are consumed yearly in deep fried food. The popularity of deep fried products is due to in past to the basic structure imposed on them by the way in which they are cooked. In deep frying, the food is totally immersed in hot fat. The fat acts as the medium of the heat transfer. Cooking in this way is more efficient than the dry heat of an oven and more rapid than boiling in water, since the higher temperature of deep frying fat results in more rapid penetration of heat into the product to be cooked (Stevenson et al., 1984).

Thus, based on the above information, it was thought to formulate, develop and evaluate the 'sev' made from Bengal gram, soya flour and kodo flour.

The main objectives are:

1. To develop the nutri-rich snack food (Sev) based on Minor Millet, (Kodo).
2. To evaluate the sensory and nutritional quality of the product.
3. To study the shelf life of the product.

REVIEW OF LITERATURE

In this chapter, an attempt has been made to assimilate the previous works within the framework of present study, which were helpful in interpretation of results. The literature referred to planning and execution of present investigation and for discussion of result. The review has been presented as follows.

2.1 Product development and optimization

Like many food processing operations, frying of food involves simultaneous heat and mass transfer (Mittelman et al., 1984). Traditional sev is prepared from bengal gram flour as a main ingredient with additives such as spices, sodium bicarbonate and salt to give the product its characteristics crispy texture (Purthi et al, 1983).

Snack foods have become a vital part of diets in the sub continent. This is because of change in conventional meal habits of the population and due to convenience offered by snack foods. The term snack or snack food is difficult to define. The dictionary meaning of the snack is 'tit-bid', which is a meal in the broadest sense (Tettweiler 1991). Thus snacks are a food, which offer a light, meals. They are convenience to eat, involving no preparation time or efforts by consumer. Snack food demand and consumption is increasing day by day. Consequently, many types of snack foods are forced into market place by manufacturer.

Pruthi et al., (1983) reported sev is a deep fat fried, salted and spiced snack item popular trough out India. Traditionally, it is prepared from Bengal gram flour (besan) as a main ingredient with additives such as a spices, sodium bicarbonate and salt to give the product it's characteristics crisp texture.

Bhattacharya and Narasimha, (2008), suggested that the textural quality of fried products is known to be influenced by use of shortening. It functions as lubricants as well as provides a crispier texture.

Beerh et al., (1985) incorporate maize flour in the preparation salted seviran and found that replacement of Bengal gram flour was possible up to

30% without affecting quality of the product. Water at 40% level at 1.5% and sodium bicarbonate at 0.1% on flour basis were found optimum for getting the desired quality of the product.

2.2 Proximate composition of sev

Very few studies have been under taken an analytical aspect of sev. The available information regarding chemical composition of sev is briefly reviewed in Table- 3. Variation in these constituents could be due to variation in the initial materials and the conditions of the preparation of food products.

Dhawan et al., (1998) studied the effect of rice flour and defatted soy flour incorporation on the preparation of deep fat fried sev and reported an increase in water absorption, frying time and hardness of the product and expansion ratio. However, soy fortified blends showed higher amount of protein and the oil absorption during frying. Product containing Bengal gram flour, defatted soy flour and rice flour in the ratio of 80:10:10 was found to be most acceptable among the products prepared from various blends.

Suryawanshi et al., (1998) reported the suitability of different varieties of chickpea for preparation of four snacks viz. khara sev, pakoda, dhokla and khari bundi using besan flour. Beerh et al., (1985) incorporated maize flour in the preparation of salted sevian and found that replacement of Bengal gram flour was possible upto 30 per cent without affecting quality of the product. Water at 40 per cent level, salt at 1.5 per cent and sodium bicarbonate at 0.1 per cent flour were found optimum for getting the desired quality of product. Berry et al., (1986) prepared potato sevian from boiled potatoes, admixed with besan, salt and spices. The product had an excellent organoleptic appeal in respect of colour, texture, taste and flavor.

Deep fat fried products, prepared from cereals, legumes and their blends are universally popular due to their desirable organoleptic profile. Grain type differs in their chemical makeup and physicochemical properties, which may account for the differences in the oil content of the snacks. Annapure (1998) correlate these parameters with the oil content in a traditional Indian extruded and deep fat fried products, sev, using flour from rice, wheat, amaranth, chickpea, cowpea, black gram and green gram. No correlations between the proximate constitute and the oil content of the fried sev was seen. Oil content in sev was minimum when fried in cottonseed oil.

Jaybhyae et al., (2010) reported that prepared ready-to-eat (RTE) barnyard millet (*Echinochloa frumentacea*) based snack food by forming thin rectangular shaped, steam cooked cold extrudate (cut pieces of dough) samples and puffing them with HTST (High Temperature Short Time Method) puffing process. Millet based extruded snack foods are prepared using twin-screw extruder from kodo millet-chickpea flour blend (70:30).

Grewal (1998) reported that soybean could be utilized in preparation of ready to use snacks (sev) having desirable organoleptic quality. Consumption of such snacks may be helpful in combating protein energy malnutrition among masses.

Deepa et al., (1992) studied the effect of addition of soy flour (10-70%) to black gram papad makings and showed no change in the dough texture, though rolling property was affected. Greater amounts of water were needed for mixing the dough with an increase in soy flour concentration. Elasticity was reduced to a minimum at 40% and was completely absent at 50%. Quality characteristics remained the same for both the raw papads. However, the quality of fried papads decreased beyond 60% addition of soy flour. Acceptability decreased with increase in percent soy flour added. The results suggest that an addition of 30-40% of soy flour would not make a significant difference in the physical and sensory characteristics of black gram papad.

Senthil et al., (2002) studied that the wheat flour and defatted soya flour blended in the ratio of 65:20, 60:25, 55:30, and 45:40 were studied in respect of dough characteristics and quality of fried savoury and sweet snacks prepared from them. As the proportion of soya flour increased, there was a slight increase in water absorption and decrease in dough stability. In fried savoury snacks the protein content increased gradually from 20.75 to 27.50%. When the proportion of soya flour was raised from 20 to 40% in the blend, the corresponding rise in protein content in fried sweet snack was from 15.75 to 21.75%.

Eggum et al., (1983) observed that soybean proteins are rich in lysine but deficient in sulphur containing amino acids, whereas cereal proteins are deficient in lysine, but have adequate amounts of sulphur amino acids, soybean is a rich source of protein with high nutritional value and excellent physicochemical properties.

Veena et al., (2005) incorporated of the barnyard millet in most common cereal based traditional foods like rice, idli, dosa, roti and sev. Cooked millet was acceptable for appearance and taste. Idles with 75% millet incorporation, were soft. Scores for colour and appearance, of dosa decreased while texture scores -increased with increased millet incorporation. Acceptable rotis were obtained at 75 per cent incorporation, whereas, highly acceptable sev were obtained at 50 per cent incorporation. In all the products (except roti), the protein, fat, total minerals, calcium, iron and dietary fibre contents increased with simultaneous reduction of carbohydrates and calorific value with increased millet incorporation. In jowar roti, protein, fat and total minerals increased, with simultaneous reduction of other nutrients.

The sorghum, chickpea and wheat flour incorporated products, biscuits (melting moments), cup cakes, laddu, chappaties and noodles were prepared by replacing the main cereal used in basic recipe by sorghum and chickpea flour. (Sikandra and Boora, 2009). The product was similar to sattu a traditional popular snack of North India. Das (1992) explored roasted peanut like product by roasting hydrated soy beans, hull removal and splitting. The product had a crunchy texture, mild nutty flavor and was devoid of urease activity. Shelf life of unspiced product was 4 month in ordinary storage and one year in air tight container. Addition of pulses not only enhances the nutritive value and sensory attributes but also improves the appearance and extrusion quality due to its water and fat binding capacity (Boye et al., 2010).

Kumaran et al., (1998) observed that minor millets are considered to be more nutritious than rice, both in terms of macro and some micronutrients. For example, samai is minor millet consumed, occasionally, by villagers and it was once one of their staple foods and crops. 100g of the edible portion of the millet contains 7.7g of protein, 4.7g of fat, 7.6g of fiber and 67 g of carbohydrate. It also had 17 mg of calcium, 220mg of phosphorus and 9.3mg of iron per 100g.

Bala (2004) observed that the millets are rich in vitamins, minerals, sulphur- containing amino acids and phytochemicals, and hence are termed as nutri- cereals. They have higher proportions of non-starchy polysaccharides and dietary fiber. Millets release sugars slowly and thus have a low glycemic index. They have been designated as 'nutritious millets'.

Minor millets include six main grain crops; namely finger millet, kodo millet, little millet, foxtail millet, proso millet and barnyard millet. Millet is nutritionally equivalent of superior to other cereals. The protein content in millet is very close to that of wheat as both contain about 11% protein by weight (Veena et al., 2005).

Kodo millet and little millet are also reported to have 37% to 38% of dietary fiber, which is the highest among the cereals and though low in fat content (Krishnan et al., 2011).

2.3 Physical and functional properties

Jonhson (1970) found that the functional properties have been the function of proteins in different food systems. These include providing acceptable colour, flavour, odour and texture to the food products. Some of the desirable functional properties are easy wet ability, good water dispensability and clear dispersion over a wide pH range, desirable viscosity, gel foaming, elasticity, film foaming and aeration properties.

Kuntz (1971) studied water uptake by besan and chicking vetch flour which is attributed primarily to their protein content and also affected by a number of factors including pH. Water absorption is considered by some of the first and the critical step in imparting desired functional properties to protein. Nath and Narsinga Rao (1981) reported water absorption capacity for soy meal(310 mg/100g), Tasneem et al., (1982) reported 342 mg /100g for soy flour while Narayana and Narsinga Rao, (1982) reported 310 mg / 10g for defatted raw soy flour. Geethalakshmi and Prakash (2000) reported that thermal treatment reduced water absorption in rice, green gram, black gram and fat absorption in green gram dhal.

Poongodi et al., (2010) studied influence of millet flour blend on physical, functional, nutritional, cooking and organoleptic characteristics of noodles prepared from composite flour of millet flour blend, whole wheat flour and soy flour. Fiber and amylase/ amylopectin ratio increased significantly ($p < 0.05$) with increase in level of millet flour blend incorporation. Cooking time developed noodles from composite flour (15-18 min) was significantly ($p < 0.01$) higher than cooking time of branded noodles (9.3 min). Mean overall

organoleptic score for developed noodle from composite flour was in the range of highly acceptable criteria (20-25). By all means, 20% level of millet flour blend incorporation was found to be acceptable. Mean glycemic index and load of developed noodle was significantly ($p < 0.01$) lower than branded noodle.

Tasneem et al., (1982) reported fat absorption capacity as 132 mg/100g for soyflour whereas Narayan and Narsing Rao (1982) reported fat absorption capacity values as 120g/100g. Heat processing increase the fat absorption capacity of soy flour and showed that fat absorption capacity of heat processed winged bean flour increased from 140g/100g to 220g/100g of flour. The ability of protein to bind fat is important for such application as meat extenders. It enhances flavor retention and mouthfeel. Although the mechanism of fat absorption has not been explained, fat absorption is attributed mainly to the physical entrapment of oil (Kinsella, 1979; Nath and Narsinga Rao, 1981). They also reported that fat absorption capacity of soy flour was 125g/100g. Fat absorption of protein may be explained by lipid protein interaction, non-conventional bonds such as hydrophobic, electrostatic and hydrogen is the forces involving in the protein liquid interaction. Narayan and Narsinga Rao (1982) studied that the heat processing increase the fat absorption capacity of soy flour. Inkaar and Ferteum (1969), Johnson (1970) and Yasumatsu et al., (1972) observed that nitrogen solubility was reliable index of emulsifying capacity of soybean. Rahma and Mostafa (1988) observed that autoclaving had a marked effect in lowering the foaming properties of peanut flour than dry heat. Foam stability also decreased as the time of autoclaving increased. This decreased was mainly due to denaturation of the protein less soluble.

EI- Adawy (2002) observed that the seeds of chickpea are large in size, salmon- white in color, and contain high levels of carbohydrate (41.10 – 47.42 %) and protein (21.70 – 23.40 %). Starch is the major carbohydrate fraction, representing about 83.9 % of the total carbohydrate. Chickpea seed has a high protein digestibility, contains high levels of complex carbohydrates, is rich in vitamins and minerals and is relatively free from anti-nutritional factors.

Kaur et al., (2005) observed that flours with high water absorption have more hydrophilic constituents, such as polysaccharides. The values of foaming capacity and foaming stability of raw chickpea flour reached to the highest point compared to all processed flours, this result may be due to the increase in concentration of protein.

Siddharth M. (2014) determined Physical characteristics of extruded snack food prepared using Little Millet (*Panicum sumatrance*) based composite flours. The results indicated that composite flour (Little millet, sorghum, foxtail millet, black gram, and chick peas flours in the ratios of 40:20:20:10:10) could be used to produce quality extrudates with acceptable sensory properties.

2.4 Nutritive value

Sood et al., (1977) reported that the carbohydrate content was found to vary from 21.6-24.51% among different varieties of soybean. The soybean seeds were found to contain 0.24% calcium, 0.69% phosphorus and 0.011% iron. Das (1992) reported a slightly higher value of 8.6% crude fiber in roasted soybean seeds. Keshun Lio (1997) reported that soybean contains highest protein content (around 40%); other legumes have a protein content between 20% and 30%, whereas cereals have a protein content in the range of 8-15%. The soybean also contains about 20% oil, the second highest content among all food legumes. Other valuable components found in soybeans include phospholipids, vitamins, and minerals. Chauhan and Tomar (1998) reported that the many promising varieties of soybean were found to contain the total ash in the range of 3.3-6.1%. Reema et al., (2006) resulted that soy supplementation significantly improved protein, fat, total and ionisable iron content in all the products. Products prepared from germinated flours showed significant decreases in phytin P and polyphenols with an improvement in starch and protein digestibility.

Neelima and Sarojini (1991) reported that the mean moisture and fat content of the snacks collected from the laboratory prepared samples showing the mean moisture content ranging from 0.95 to 7.53 per cent which might be due to variation in the initial moisture content of the dough/batter and extent of frying. Except in chegodi, the moisture content of other market samples were higher than that of laboratory samples.

Little millet has reasonably good levels of protein but very poor amino acid values. In general, minor millets are considered to be more nutritious than rice, both in terms of macro and some micronutrients. For example, samai is minor millet consumed, occasionally, by villagers and it was once one of their staple foods and crops. One hundred grams of the edible portion of the millet contains 7.7 grams of protein, 4.7 grams of fat, 7.6 grams of fibre and 67 grams of carbohydrate. It also had 17 mg of calcium, 220mg of phosphorus and 9.3 mg of iron (Kumaran et al., 1998).

Ushakumari et al., (2004) found that millet is a minor cereal of high nutritional value, but its consumption is limited; this is thought to be mainly due to the non-availability of ready-to-use or ready-to-eat millet products. It is suggested that processing millet to prepare ready-to-eat foods may increase its economic and nutritional value. Studies were, therefore, conducted to evaluate the functional properties of popped, flaked, roller dried and extrusion cooked millet for potential use as ready-to-eat products.

Bhama and Sadana (2004) observed significant variation in the chickpea flour and their products (fried dhal and dhokla) in biochemical constituent such as calcium, iron and zinc. Flour contained 55.3, 5.26, 3.16, fried dhal 45.3, 4.33, 2.56 and dhokla contained 62.3, 6.11 and 2.62 mg/100g calcium, iron and zinc respectively. Sikandra (2009) suggested that chickpea is not merely a good source of lysine, but a good source of riboflavin also generally deficient in predominantly cereal based diets. Supplementation has improved the nutrient composition, sugar and mineral content of the products. Supplemented products have acceptability as good as control product. Minor millets include six main grain crops; namely finger millet, kodo millet, little millet, foxtail millet, proso millet and barnyard millet. Millet is nutritionally equivalent or superior to other cereals. The protein content in millet is very close to that of wheat as both contain about 11 per cent protein by weight (Veena et al., 2005).

Bhama et al., (2006) investigated the proximate and mineral composition of chickpea and their products i.e. moisture, ash, protein, fat, crude fiber, calcium, iron and zinc as 8.01%, 2.39%, 21.85%, 4.59%, 1.10%, 50.2, 4.57, 2.88mg/100g while fried dhal contained 3.00%, 3.71%, 22.06%, 19.21%, 1.74%, 4.33%, 2.50% whereas in dhokla 6.00%, 4.26%, 16.25%, 4.57%, 1.61%, 6.11% and 2.62% respectively.

Yadav (2008) resulted that instant soy-fortified upma mix prepared using the optimum levels of ingredients contained: 0.37±0.02% moisture, 16.2±0.15% protein, 30.4±0.40% fat, 2.1±0.05% ash, 1.9±0.08% crude fibre and 45.43±0.05% carbohydrate (by difference). Changes in the quality parameters of stored soy-fortified instant upma mix under ambient (15-35°C) and 37°C temperature conditions were monitored by evaluating peroxide value, free fatty acids. Ahamed et al., (1997) studied on the oil content of fried noodle-like products prepared from a blend of soya flour and starch in ratios ranging from 80:20 to 20:80 of soya flour starch. Sikandra et al., (2009) reported that the extruded snacks of soybean contained 11.12% protein, 0.8-1% fat, 3.0-3.2% ash, 1.25-1.40 g/cm³ bulk density and 1.72-1.77 expansion ratio.

Although sev is prepared from Bengal gram flour as the major ingredients. Various workers have attempted to incorporate other raw materials to partially replace Bengal gram flour.

Berry et al., (1986) prepared potato seviran from boiled potato admixed with besan salt and spices. The product had an excellent appeal in respect of colour, texture, taste and overall flavor.

Singh (1988) Incorporated maize flour, rice flour and defatted soy flour in Bengal gram flour for preparation of sev like products. There was a considerable increase in water absorption of blends, frying time and hardness of the products.

Manan et al., (1991) stated that the product made from 80:20 blend of colocasia and besan had excellent sensory qualities like colour, texture, taste and overall acceptability.

Singh and Seetha (1993) in a study using the commonly consumed grain legumes, the score on general acceptability of a snack food was the highest for that from Bengal gram followed by lentil, pigeon pea and green gram, whereas, the oil absorption by the product was highest for lentil followed by black gram, chickpea and green gram. They further reported that the flour particle size, starch and protein content significantly influence oil absorption of seviya. They also reported that the oil absorption of the product differed significantly among genotypes but clear-cut differences were not found between desi and Kabuli groups of chickpea genotypes.

Hulse et al., (1980) reported that the kodo millet contains 9.8% protein, 3.6% fat, 3.3% ash, 66.6% carbohydrate and 5.2% crude fiber. Kodo millet is also good source of micro nutrients and B- group vitamins. The millets has protein of balanced amino acid profile and a good source of methionine, cysteine and lysine. The millet grain contains about 66.5% of carbohydrate, a high proportion of which is in the form of non- starchy polysaccharide and dietary fiber which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to blood stream during digestion.

Itagi, (2003) conducted storage study on foxtail and little millet based mixes and observed that there was no apparent effects on sensory quality when stored for six months in two different packaging materials, polythene bags and aluminum pouches.

MATERIAL AND METHODS

The present investigations on, "**Optimization and formulation of nutria-rich snack food (sev).**" were carried out in the Department of Food Science and Technology, JNKVV, Jabalpur (M.P.). The materials used and methods adopted for the purpose of investigation has been presented in this chapter.

3.1 Materials and methods

3.1.1 Food commodities

Chickpea (*Cicer arietinum*), kodo (*paspalum scrobiculatum*), soybean (*Glycine max*) were procured from the local market of Adhartal, Jabalpur.

3.2 Preparation of flours

Grains were thoroughly cleaned to remove dirt, stone, dust, wood, insect excreta/ feathers and admixture of other food grains. The clean graded materials were grind in the electric grinder to make flour of required size.

3.3 Development and Optimization of sev mixes & it's sev

Several compositions of raw materials and main ingredients were tried to arrive at the desired formulation with optimum percentage as recommended by acceptability studies. All experimental samples were prepared using the traditional method. Various acceptability parameters such as texture, colour, appearance, flavor, taste, after taste and overall acceptability were considered deciding factor by using the method described by Amerine et al., (1965).

3.4 Preparation of blends

Table 1: Different formulations of sev fortified with soy and kodo flour.

S. No.	Chickpea flour (%)	Soy flour (%)	Kodo flour (%)	Symbol
1	100	-	-	S ₀ (control)
2	80	10	10	S ₁
3	70	15	15	S ₂
4	60	20	20	S ₃
5	50	25	25	S ₄

Table 2: Important Ingredients

S. No.	Ingredients	Quantity (g/100g flour mixes)
1	Red chili powder	1.0
2	Turmeric powder	0.4
3	Black pepper	0.4
4	Salt	3.0
5	Oil	5ml
6	Cumin seed	3.0
7	Water	As required

3.5 Preparation of sev

Sev blends were prepared after addition of oil, water, salt and all ingredients in 100 gram of mixed flour. The flow sheet illustration the preparation of sev has been presented in fig 3.1. All the ingredients were taken in a plastic bowl mixed and kneaded well with had by addition of water. The quantity of water added was adjusted to such a level that finally kneaded dough was pliable. The dough was then extruded through a manually operated sev press directly into a frying pan containing about one liter of double filtered refined soybean oil maintained at 180 °C (approximate)

after completion of frying sev were taken out of pan and held above the oil to allow the excess oil to drain back into the pan. The deep fat fried sev were brought to room temperature and packed in different packaging material viz. LDPE (low density polyethylene) and polypropylene pouches pouches and stored at room temperature.

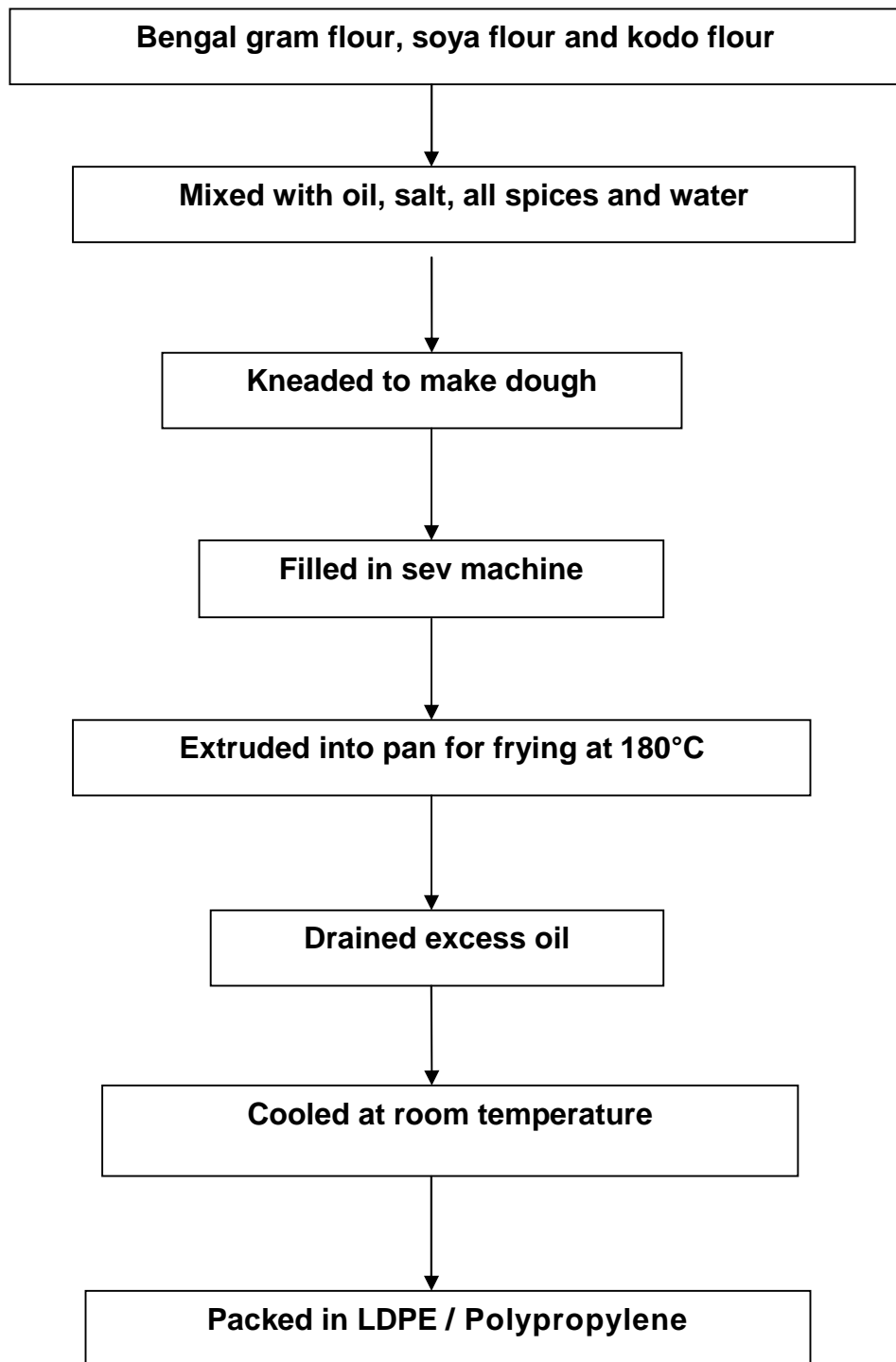


Fig.3.1 Flow sheet for preparation of sev

3.6 Sensory evaluation of products

The sensory quality characteristics of the products such as colour, taste, texture, flavor and overall acceptability were evaluated by panel of judges using nine point hedonic scale as described by Amerine et al., (1965).

The rating was given as per the hedonic rating as mentioned below:

S. No.	Remark	Score
1	Like extremely	9
2	Like very much	8
3	Like moderately	7
4	Like slightly	6
5	Neither like nor dislike	5
6	Dislike slightly	4
7	Dislike moderately	3
8	Dislike very much	2
9	Dislike extremely	1

Sensory Attributes	Code 1	Code 2	Code 3	Code 4	Code 5
Colour & Appearance					
Flavor					
Taste					
Texture					
Overall acceptability					

3.7 Physical properties

3.7.1 Yield of sev

The final yield of deep fat fried sev was measured and calculated as total product obtained by the total blend used expressed as gm/100gm.

3.7.2 Diameter

The diameter/ thickness of product were measured using a thickness meter and average mean of 10 values was reported and expressed as millimeter.

3.7.3 Frying time

The time taken by sev for cooking measured using a stop watch and expressed in seconds.

3.8 Proximate composition of sev mixes

The nutritional evaluation of mixed flour with respect to various constituents was carried out by the following procedures.

3.8.1 Determination of moisture content

The moisture content of the sample was determined by the using moisture meter.

3.8.2 Determination of protein content

The protein content in sample was determined by using conventional Micro-Kjeldhal digestion and distillation procedure as given in AOAC (1992).

3.8.3 Determination of Fat content

The fat content of the sample was determined by the procedure as described in AOAC (1992) using soxh plus fat analysis system.

3.8.4 Determination of Ash content

The ash content present in the sample was determined according to the procedure given in AOAC (1992).

3.8.5 Determination of crude fibre

The crude fiber was determined by the method as described in AOAC (1992).

3.8.6 Determination of Total Carbohydrates

Total carbohydrate in the sample was estimated by acid hydrolysis method as described by Hassid and Abraham (1965).

3.9 Functional properties of sev mixes

3.9.1 Fat absorption capacity (FAC)

Fat absorption capacity was measured by the method of sosulski et al., (1976).

3.9.2 Water absorption capacity (WAC)

Water absorption capacity was measured by the methods of Sosulski et al., (1976).

3.10 Statistical analysis

The data obtained from various experiments were statistically analyzed. A complete randomized design was adopted for statistical analysis of data of experiments related to storage studies by following the procedure as described by Panse and Sukhatme (1963).

3.11 Storage studies

The storage stability of sev mixes (best mix finalized in sensory studies along with control) were carried out using polypropylene and low density polyethylene (LDPE) pouches for a period of 3 month at ambient conditions. 100g sev were drawn periodically after 90 days. All samples were drawn periodically after 0, 30, 60 and 90 analysed for sensory qualities according to procedure as described earlier in the chapter.

RESULTS

The present investigations were carried out in the Department of Food Science and Technology to test the suitability of cereals, pulses and millet for the preparation of sev. The results obtained during the course of investigation have been described in this chapter in the form of Tables and figures.

4.1 Proximate composition of sev mixes

The proximate composition of sev flour viz. moisture, fat, protein, carbohydrate, crude, fiber, and ash content were determined in different products made from different ratio of chickpea, kodo and soya flour. The mean values have been tabulated with statistical indices (C.D. values) to arrive some valid conclusion.

4.1.1 Moisture Content

It is evident from the Table 3 that moisture content varied of 5.98 percent to 8.48 percent in various treatment combinations. All the treatments moisture was at par with each other. Treatment S₀ (100% chickpea flour) and S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) was found with highest moisture content followed by S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour) and S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour). The lowest moisture content (5.98%) in treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour). All treatment combinations were having significant differences among each other.

4.1.2 Protein content

Data presented in the Table 3 reveals that protein content in various flour varied from 20.68 percent to 26.65 percent. Treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) was found to be highest protein percent followed by S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour). Treatment S₀ recorded lowest protein content (20.68). All the treatments showed significant differences among each other.

4.1.3 Fat content

Fat content is related to the existing oil content of different flours and additional oil absorbed during deep fat frying of the sev. Table 3 indicates that mean values of fat content of sev.

Fat content exhibited variations from 4.20 percent to 10.20 percent. Treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) recorded maximum fat content followed by S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour). Treatment S₀ had lowest fat content (4.20). All the treatments were significantly differs from each other.

4.1.4 Carbohydrate content

It is evident from Table 3 that carbohydrate content of different treatments was found to be ranged from 49.07 percent to 60.44 percent. S₀ (100% chickpea flour) and S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) had numerically the maximum carbohydrate content followed by S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour) and S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour). S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) got the lowest score (49.07). All the treatment combinations showed significant difference among each other with respect to flour combinations and spices.

4.1.5 Ash content

It is evident from the data as presented in Table 3 that ash content found to be ranged from 2.40 percent to 3.00 percent in different treatment combinations. The maximum ash content recorded in S₀ (100% chickpea flour), S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour) followed by S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour). Treatment S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) was found to have minimum ash content (2.40). All the treatments differed significantly from each other.

4.1.6 Crude Fiber content

It is clear from Table 3 that crude fiber ranged from 3.2 percent to 5.5 percent in different treatment combinations. The maximum fiber content recorded in S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) followed by S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour). All the treatments differed significantly from each other.

Table 3: Proximate analysis of sev mixes

S. No.	Treatment	Moisture content (%)	Carbohydrate (%)	Protein (%)	Ash (%)	Fat (%)	Crude Fiber (%)
1	S ₀	8.48	60.44	20.68	3.00	4.20	3.2
2	S ₁	6.86	58.04	23.40	2.40	5.80	3.5
3	S ₂	6.77	53.86	24.27	2.80	7.80	4.5
4	S ₃	6.18	52.16	25.06	2.80	8.80	5
5	S ₄	5.98	49.07	26.65	2.60	10.20	5.5
6	SEM±	0.050	0.513	0.058	0.057	0.068	0.051
7	CD at 5%	0.159	1.616	0.183	0.181	0.215	0.162

4.2 Sensory Evaluation of sev

For the initial launching of any food product in the market, the product should undergo sensory evaluation test to show their acceptability. Under present investigations, the sev prepared from various flours were evaluated by organoleptic test. Different types of sev were developed from different formulations of chickpea, kodo millet, and soy flours. A panel of 10 judges were required to be evaluated by product and asked to give their rating on 9 point hedonic scale on the various quality attributes like colour and appearance, taste, flavor, texture, and overall acceptability.

The mean score of different sensory quality attributes have been tabulated in Table 4.

4.2.1 Colour and Appearances

It is clear from Table 4 that the formulation S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) was significantly superior over the rest of the combinations with mean score 8.70. The data revealed that increase in the ratio of kodo flour (above 20%) slightly decreased the mean scores for colour and appearance of sev. The treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) got the least mean score (7.50) for colour. All the treatments showed significant relationship among themselves.

4.2.2 Taste

It is obvious from the Table 4 that the formulation S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) exhibited significantly higher score (8.40) for taste followed by treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour). The treatment S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) got the least mean score (7.55) for taste. All the treatments showed significant relationship among themselves.

4.2.3 Texture

As evident from Table 4 in case of texture the S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) got the maximum score (8.30) while the treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) and S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) got the least score (7.80 and 7.90). Treatments were showed significant relationship in respect of flour combination and spices also.

4.2.4 Flavour

The appraisal of Table 4 showed that the treatment S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) got the maximum score (8.60) while the treatment S₀ (100% chickpea flour) and S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) got the least score (8.40 and 8.35). Treatments were showed significant difference among each other.

4.2.5 Overall acceptability

As appraisal of Table 4 indicated that the treatment S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) was liked the very much with overall highest score of 8.5 followed by S₀ (100% chickpea flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour) which were statistically at par with each other. The least score was recorded by the treatment S₁ (80% Chickpea flour, 10% Soy flour and 10% Kodo flour) with score of 7.68. All the treatment showed significant relationship among each other.

Table 4: Sensory attributes of sev

S. No.	Treatment	Color & appearance	Taste	Texture	Flavor	Over all acceptability
1	S ₀	7.90	8.20	8.10	8.40	8.15
2	S ₁	8.50	7.55	7.90	7.80	7.93
3	S ₂	8.40	7.95	8.00	7.70	8.01
4	S ₃	8.70	8.40	8.30	8.60	8.5
5	S ₄	7.50	8.35	7.80	8.35	8
6	SEM±	0.066	0.096	0.082	0.051	0.063
7	CD at 5%	0.210	0.302	0.261	0.162	0.201

4.3 Functional properties of sev mixes

Functional properties namely water absorption capacity and fat absorption capacity are supposed to affect the quality of various baked or fried products. Before going to actual preparation of products. The studies on the various functional properties are important. The results obtained on these functional properties reveal that.

4.3.1 Water absorption capacity

It is clear from Table 5 that the water absorption capacities of various flours range were found to be from 105 to 138 ml/100g. The S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) exhibited highest water absorption capacity among all the combinations. The treatment S₀ (100% chickpea flour) and S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) had the least water absorption capacity (105 and 108).

4.3.2 Fat absorption capacity

As seen from Table 5 that the fat absorption capacity varied from 205 to 217 ml/100g of flour in different treatment combinations. The treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) had the maximum fat absorption capacity followed by S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) and S₂ (70% Chickpea flour+15% Soy flour and 15% Kodo flour). The treatment S₀ (100% chickpea flour) and S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) had the least fat absorption capacity (208 and 205).

Table 5: Functional attributes of sev

S. No.	Treatment	Water absorption capacity (ml/100g)	Fat absorption capacity (ml/100g)
1	S ₀	105	208
2	S ₁	108	205
3	S ₂	119	213
4	S ₃	132	215
5	S ₄	138	217

4.4 Physical characteristics of sev

The sev prepared by 100 g of mixed flour with the all ingredients like, red chili powder, turmeric powder, black paper, salt, oil, cumin seed and water to gave acceptable colour, taste and texture of the product.

After making dough of desired consistency the sev was deep fat fried and various observation like water uptake, frying time, yield, diameter, expansion ratio and oil uptake were recorded.

4.4.1 Frying time

An appraisal of the Table 6 indicates that treatment combination S₀ (100% chickpea flour) and S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) recorded lowest frying time 75 and 78 seconds followed by S₂ (80 second) and S₃ (84 second).

It was found that treatment S₄ recorded highest frying time (88 second).

4.4.2 Yield of the product

As seen from Table 6 that highest yield (130g/100 flour) was observed for treatment S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) followed by S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour).

The lowest yield obtained from the initial treatment combination of S₀ (123 g/100g of flour).

4.4.3 Diameter of sev

On perusal of the Table 6 it was found that diameter of sev prepared from mixed flour ratio ranged from 3.21 to 3.55mm. The mean value of diameter of sev from different flour ratio indicates that sev made from treatment S₀ (100% chickpea flour) had the minimum diameter whereas but flour ratio 50:25:25 (chickpea:kodo:soy) recorded maximum diameter (3.55). It is evident that proportion of kodo and soy flour was responsible for giving more diameter to the product.

4.4.4 Water uptake

The Table 6 showed the amount of water requires for the preparation of dough of desired consistency for the sev made from chickpea flour kodo flour and soy flour. The mean value obtained, indicates that initial treatment combination required 60ml/ 100g of flour of water for dough preparation which was lowest in comparison to others. Maximum water was required for other combinations. It was found that the treatment S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) recorded highest water uptake (65 ml).

4.4.5 Oil Uptake

The Table 6 showed that, oil absorbed by the sev during deep fat frying was determined by soxhlets extraction procedure and the mean value of oil absorb by the sev was recorded. The data reveals that both S₁ (80% Chickpea flour+10% Soy flour and 10% Kodo flour) and S₀ (100% chickpea flour) were found with highest oil absorption and S₃ (60% Chickpea flour, 20% Soy flour and 20% Kodo flour) lowest in oil absorption.

Table 6: Physical attributes of sev

S. No.	Treatment	Frying time (second)	Yield (g/100g flour)	Diameter (cm)	Oil Uptake (ml/100g sev)	Water uptake (ml)
1	S ₀	75	123	3.21	23.28	55
2	S ₁	78	125	3.19	22.99	57
3	S ₂	80	127	3.35	22.93	60
4	S ₃	84	130	3.46	22.17	63
5	S ₄	88	128	3.55	22.63	65

4.5 Storage stability of sev mixes

The storage study was conducted for 90 days at ambient room temperature ($30^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and $60\% \pm \text{RH}$). Two packaging materials viz Polypropylene and low density Polyethylene (LDPE) were used. All the samples were analyzed periodically after 0, 30,60 and 90 days for Sensory Evaluation and the obtained results have been presented as given below.

Table 7: Effect of storability on sev mixes

Formulation	0 days	30 days	60 days	90 days
P ₁ S ₀	8.80	8.60	8.10	7.40
P ₂ S ₀	8.80	8.40	7.50	6.70
P ₁ S ₁	8.80	8.20	7.88	7.48
P ₂ S ₁	8.21	8.20	7.30	6.40
P ₁ S ₂	8.45	7.90	7.08	6.90
P ₂ S ₂	8.43	7.80	7.00	6.88
P ₁ S ₃	8.85	8.20	7.86	7.50
P ₂ S ₃	8.80	8.18	7.34	6.80
P ₁ S ₄	8.33	8.25	7.50	7.30
P ₂ S ₄	8.30	8.20	7.20	6.00

P₁- low density Polyethylene, P₂- Polypropylene,

Mean score of overall acceptability of sev prepared from different mixes are presented by Table 7. It has been showed that overall acceptability of all sev was decreased with increase in storage period. Formulation S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) packed in P₁ (low density Polyethylene) exhibited the highest acceptability (7.50) up to the end of storage at 90 day followed by packed in polypropylene (P₂ S₂) with 6.88 score as compared to control sample.

DISCUSSION

Traditionally , since ancient times several products are being made using cereals as well as pulses. These are generally consumed as items of snacks or as special items for different occasions in different parts of India. Among these are snacks, sev, bundi, laddu, etc. are some of the popular items prepared at home as well as commercial level.

The chapter deals with the justification of the experimental findings under taken in the proposed research program. The results have been explained with the help of reported values of various parameters given by different workers. The results have already given in detail in the preceding chapter.

5.1 Development of chickpea, kodo and soy flour based sev

Like many food processing operations, frying of food involve simultaneous heat and mass transfer (Mittleman et al., 1983). Apart from physicochemical changes, the loss of moisture from the product and entrance of oil product (Gamble and Rice1987) are of importance during frying. As these determine the product quality process standardization and energy expenditure (Blumenthal, 1991). The information on the development of fried products is meager. Some studies have been undertaken on traditional snack foods by scientists, who explored various aspects of research. These included standardization of process parameters of existing products, shelf life studies, replacing a part or whole of ingredients used in a product, value addition of products by way of incorporation of novel ingredients with either nutritional, functional or storage purposes, using advanced technology for better processing, inventing new packaging materials etc. (Neelima and Sarojini 1991; Siddharth, M. 2014; Singh *et al.* 2003; Leena Sebastian 2005). Dhawan et al., (1998) developed the deep fat fried sev by incorporation of rice flour and deffated soya flour. Annapure (1998) developed the deep fat fried sev using flour from rice, wheat, amaranth, chickpea, cowpea, black gram and green gram. For mouth feel and overall acceptability the sev fortified with 20 percent Soybean flour was the highest scored product (Dhore, 2011).

5.2 Optimization

In present study, oil is used for making acceptable crispers texture of the sev. The optimization of various ingredients used in the sev preparation given in chapter III. 8-10 ml of oil /100gm of instant mix required for improving the texture of sev dough. Dough with above 14 ml oil was more crumbly than the control dough and difficult to sheet and handle to make a sev. Sev prepared from combination of S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour) were found to highest acceptable texture as compare to other samples. This may be due to addition of different soy and kodo millet flour in appropriate combination. The textural quality of fried products is known to be influenced by use of shortening also. It functions as a lubricant as well as provides crispers texture to the product. The ingredients of sev standardized by Geeta, lakshmi and Prakash, (2000) are in contrast with the present study.

5.3 Proximate composition of sev mixes

The moisture content of sev in which chickpea flour was used had higher moisture content. This indicates that the chickpea flour was responsible for water higher absorption in the product. The variation in moisture content of sev seems to be due to difference in water absorption capacity of various proportions of flour for making dough. There were also variations in frying time. These results were well supported by Kulkarni et al., (1994).

The amount of protein in different blends was found to decrease with increase of chickpea flour. This reduction in protein content could be correlated with higher oil absorption during frying time as well as low amount of protein content in chickpea and kodo used for fortification. Several investigations also (Pruthi et al., 1983; and kulkarni et al. 1994) reported that this was due to low protein content in various type of cereals and millets flour used for preparation of sevirian product. These results support the present findings.

As can be seen from the Table 3 gradual increase in the protein and fat will be increase and decrease in moisture and ash with modification was

observed in sev mixes and sev. This may be due to addition of soy and kodo flour in modified recipe. The similar results are reported by Dhore (2011). Senthil et al., (2002), Veena et al., (2004) the findings of present study are in contrast with the finding of Chouhan and Tomar (1998) with regards to soya snacks. The nutrient content of sev was found to more as compare to flour mixes. This may be attributed to evaporation of moisture during frying. However, the increase in fat content was much higher due to absorption of fat during frying (Geethalakshi and Prakash, 2000).

5.4 Acceptability studies of sev

Overall Acceptability is depend on the sensory evaluation of the product. Sensory evaluation is important to judge the quality of any product. It is based on colour and appearance, taste, flavor, texture (hardness) and over all acceptability. The supplementation of soy and kodo flour (over the 20:20) decreased the sensory quality characteristics of the developed sev. As the ratio of soy and kodo flour increased in the blend the various sensory properties decrease as observed in the present investigation. However, the fortification of flour with spices enhanced the sensory attributes of sev.

The data reveals that as the ratio soy and kodo flour increased in the dough, the sensory attributes viz., taste, flavor, colour, and texture increased up to the level of 60:20:20 (Chickpea:Soy:Kodo) and then decreased. Different spices used in the product showed significant differences among each other. The flour ratio and spices had significant effect on the quality of the product.

Generally, sev is prepared from Bengal gram flour. But in present investigation soy and kodo flour was used as a substitute and overall acceptability of sev depends on soy and kodo flour. On the basis of sensory evaluation 60:20:20 (Chickpea:Soy:Kodo) blend was considered the best as compare to other. The crisper texture in the products with added fat enhanced the acceptability scores. The similar result reported by Geetalakshmi and Prakash (2000). Findings of Deepa et al., (1992) regarding addition of 30-40% soybean flour in prepared are in contrast with the present findings whereas results of Dhore (2011) are similar to present study.

5.5 Functional properties of mixed sev flour

The quality of several fried products depends upon its major constituents items from which they are made and various functional properties such as water absorption capacity and fat absorption capacity. The present investigation was carried out to prepare sev using mixed flours having different flours. Studies of water absorption capacity of proteineous material are useful in assessing potential food application products. Water absorption capacity expressed in ml of water by 100 gm of flour was determined from instant mix made from different pulses and kodo millet are reported in Table 5. The water absorption capacity was found to be maximum in formulation S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) and S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour). Water absorption capacity was increased due to addition of different pulse flour. Similar finding were reported by Dhawan et al., (1998), Senthil et al., (2002) in with regards to soy flour incorporated. Denaturation of protein, interaction of components and structural damage to starch on heating lead to higher water absorption capacity in pulse flours (Deoskar, 2004). Carbohydrate present in flour may play a role in water absorption capacity. During heat gelatinization of carbohydrate swelling of crude fiber may occur which could also increased water absorption capacity. The findings are well collaborated by the reported values of Bhatt (2003).

The Table 5 clearly indicated that S₃ (70% Chickpea flour+20% Soy flour and 20% Kodo flour) recorded highest fat absorption capacity. Increase in fat absorption capacity may be due the addition of pulse flour in sev. The similar value was reported by Nath and Narsing Rao (1981) for soya meal and higher value reported by Tasneem et al., (1982) with regard to soya flour. Heat processing increased the fat absorption capacity of different pulse flour blends used in sev preparation. This increase could be due to both dissociation of proteins that may occur on heating and also denaturation which is expected to unmask the non polar residue from the interior of the molecules. Since the products based on pluses absorbed lesser fat on thermal treatment, it can be concluded that it did not affect the textural quality adversely. The similar result reported by Geethalakshmi and Prakash (2000).

5.6 Physical characteristics of sev

5.6.1 Frying time

Frying time indicates the quality of initial ingredients used and the final product obtained. Increase in frying time shows the capacity of flour to absorb more moisture and oil. The result obtained interprets that kodo and soy flour required more time to fry as compare to chickpea flour.

5.6.2 Yield of the product

It appears that whenever the proportion of kodo and soy flour increased the yield of the product also increased. Thus the proportion of kodo and soy flour was the main facto responsible for increase in yield. It show that water and fat absorption capacity of kodo and soy flour was higher than the of chickpea flour.

5.6.3 Diameter of sev

Dimeter of sev can be explained on the basis of water and fat absorption capacity of flour. As kodo flour was found to have maximum water and fat absorption capacity and it is responsible for more diameter of the product. The higher bulk density of ingredients incorporated in modified mixes. However the findings of Singh et al., (2003) are in contrast with the present findings.

5.6.4 Water uptake

The amount of water required for making dough of desired consistency for the sev preparation from the mixed flour. It depends on the chemical characteristics of the particular flour. The requirement of amount of water varied with the types of the flour used for preparation of sev.

5.6.5 Oil uptake

The oil absorption in the sev during frying was increase with amount of soy flour was decrease. The more absorption of oil by the sev from chickpea, kodo and soy flour could be easily justified on the basis of the related observation on water absorption capacity and fat absorption capacity, and yield of the product.

Singh and Dhawn (1988) also studied the effect of incorporation of maize, rice and defatted soy flour in besan for the preparation of sev showed the higher values of water absorption capacity, frying time and expansion ratio which supports the present findings.

5.7 Storage studies

During storage of sev mixes there were a marginal increase in moisture content and overall acceptability in both the packaging materials. Similar findings were also observed by Singh et al., (2000). The storage of the best sev mixe found in sensory evaluation was selected for storage studies. Sev mixes packed in polypropylene and low density polyethylene and stored at ambient temperature for 90 days. The overall acceptability of S₁ (80% Chickpea flour, 10% Soy flour and 10% Kodo flour) and S₂ (70% Chickpea flour, 15% Soy flour and 15% Kodo flour) was significantly affected by different processing variables and declined with increased in storage period. The highest mean scores for overall acceptability was found in low density polyethylene bag for sev up to 90 days as compare to polypropylene. A marginal increase in moisture content of the sev might be due to the uptake of moisture from atmospheric humidity. Similar results were also observed in different packaging materials by Sathe et al., (1982).

SUMMARY, CONCLUSION AND SUGGESSTION FOR FURTHER WORK

6.1 Summary

The present investigation entitled “**Optimization and formulation of nutri-rich snack food (Sev)**” was conducted in Department of Food science and Technology, to develop the better quality of product by utilizing the kodo and soy with chickpea flour. The salient findings obtained during the investigation have been presented in the following points.

1. The sev prepared from mixed flour (S₃) was found highly acceptable in all sensory parameters as colour and appearance, flavour, texture, taste, and overall acceptability with ratio 60:20:20 (chickpea, kodo and soy flour).
2. The water absorption capacity was found to be maximum in S₄ (50% Chickpea flour+25% Soy flour and 25% Kodo flour) and S₃ (60% Chickpea flour+20% Soy flour and 20% Kodo flour).
3. Chickpea flour was found to have minimum water absorption capacity whereas, kodo and soy flour had maximum.
4. Maxing of kodo and soy flour in chickpea flour in higher amount showed higher fat absorption capacity.
5. As the ratio of kodo and soy flour increased the water oil uptakes increased but oil uptakes decreased. This promotes the yield of the final product.
6. Maximum frying time was taken by sev made from higher ratio of kodo and soy flour.
7. Diameter was also higher of the sev prepared from higher ratio of kodo and soy flour in the blends.
8. Sensory evaluation showed a comparative rating of all the quality attributes of sev made from chickpea, kodo and soy flour. The overall acceptability of the product was good up to the level of 60:20:20 (chickpea, kodo and soy flour).

9. Sev with ratio of 80:10:10 (chickpea, kodo and soy flour) was found to be inferior in all sensory quality characteristics.
10. The moisture content of sev packed in different packaging material showed a gradual increase. The sev which was packed in LDPE (low density polyethylene) bags showed lesser amount of moisture intake as compared to polypropylene.
11. LDPE (low density polyethylene) was observed to be safe for storage of the deep fat fried products as compared to polypropylene due to lesser enhancement of flavor.

6.2 Conclusion

The purpose of this experiment was to enhance the utilization of kodo and soy flour as well as development of better quality sev with lesser cost. On the basis of present findings it was concluded that 60:20:20 ratio of chickpea, kodo and soy flour was highest acceptable with respect to all sensory attributes like colour and appearance, taste, flavor, texture and overall acceptability and physical characteristics of final product. Functional properties are directly related to the quality of final product. In the present investigation high content of oil in the blends having high ratio of soy flour may develop off flavor. Thus it could not be used beyond the 20 percent. LDPE (low density polyethylene) was safe as packaging material for storage of sev because they had low moisture.

6.3 Suggestions for further work

Although the present investigation has given much useful information on various aspects of “sev and sev flour”, yet some more work should be carried out on the following aspects.

1. The other micro nutritional parameters should be studied in the developed sev.
2. Assessment of microbial load at various stages of processing and storage should be evaluated.
3. Storage studies should be made for longer duration.
4. Other cereals and millets should be incorporated in the product.
5. The textural properties of sev should be done by texture analyzer.

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Scientific interests

- Research Works on Snacks and Extruded product development.
- Canning of fruits and vegetables.

For the partial fulfilment of the master's degree programme he was allotted a research work on "**Optimization and formulation of nutri-rich snack food (Sev)**" which was successfully conducted by him and being submitted in the form of the thesis.