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Nutritional enhancement of extruded snacks by incorporation of oat and soybean flour

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Abstract
The present investigation was carried out to assess the suitability of different ingredients in development of extruded snack food and to observe the effect of different ingredients on the sensorial and nutritional properties of prepared snack. The studies were focused on standardizing the concentration of different ingredients to a level of acceptable quality. The multigrain extruded snacks were prepared by 50% chickpea flour and varying concentration of rice flour (50-10%) and oat and soybean flour (10-20%). The results revealed that the extruded snacks prepared from composite flour (Chickpea, Oat, Soybean and Rice flour in the ratios of 50: 10: 10: 30) was found to be more acceptable with respect to mentioned sensorial quality parameters and incorporation of oat and soybean flour in the snack food increased its nutritional value.

Keywords: extruded snacks, soybean, oat, rice, flour

Introduction
Functional food is the topic of interest in the food and nutrition industry (Syed *et al.*, 2010) [14]. Snack foods have become an integral part of the eating habits of majority of the Indian population. Extrusion technology today is being extensive used in commercial development of snacks and the ingredients like corn, chickpea and rice are ideal materials for extrusion processing (Chinnaswamy and Hanna, 1988) [3]. Oats (*Avena sativa*) have a high β-glucan content which is of advantage in human nutrition to enhance immune response to infection (Ramakers *et al.,* 2005 and Tsikitis *et al*., 2004) [13, 15] and to be responsible for lowering serum and plasma cholesterol levels (Naumann *et al.,* 2006 and Lasztity, 1998) [10, 8]. Soybean also has great potential to provide good quality proteins and calories at low prices. Hence, the present research was undertaken to investigate the possibilities of exploring oat and soybean in development of extruded snack with enhanced nutritional properties.

Materials and Methods
The present investigation was carried out in Department of Food Science and Technology, College of Food Technology, VNMKV, Parbhani. The ingredients such as Chick Pea Flour (*Cicer arietinum* L.), Oat (*Avena sativa*), Soybeans *(Glycine max L.)*, Rice (*Oryza sativa L.*) flour, edible oil and other minor ingredients like salt, spices, etc. were purchased from local market of Parbhani. Chemicals used in this investigation were of analytical grade. Spice mix was prepared by mixing *amchur* powder (10g), black pepper powder (4g), cumin powder (5g), chilli powder (3g), black salt (2g) and citric acid (1g) with 50ml of edible oil (Poshadri, 2009) [12].

Composite flour formulation for preparation of extruded snack
The Control flour was prepared by using 50g Chickpea flour and 50g of rice flour as standard (Guria, 2006) [6]. For the levels of oat and soybean, different preliminary trials were carried out followed by informal sensorial evaluation of product to optimize the maximum suitable concentration of soybean and oat incorporation. It was observed that if the concentration of Chickpea flour incorporation is reduced beyond 50 per cent then the overall quality of prepared product is being drastically reduced as product is becoming brittle while minimum concentration of rice flour required to prepare product should be 10 per cent otherwise the product is becoming hard. Hence, on the basis on preliminary trials, the recipes were finalized for experimentation from Table-1.

Method for preparation of Extruded product
The production of "extruded product" was started by dry mixing the composite flour in a bowl. Then the spice mix and other dry ingredients were added and mixed thoroughly. The mixture was kneaded in the bowl and dough was formed with using enough water added.
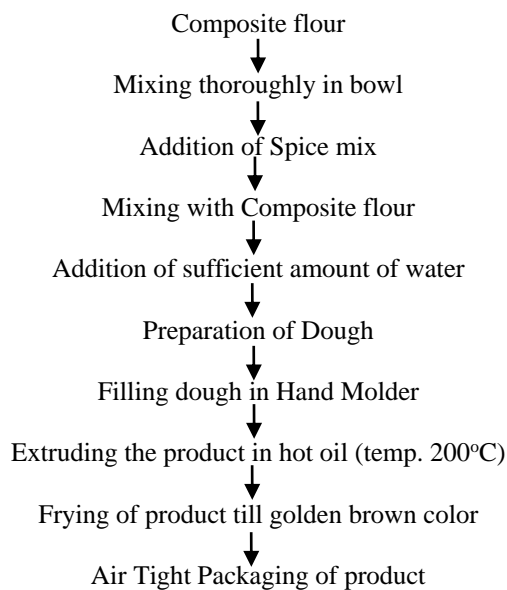
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Then, the dough was placed into hand mold before pressing it into hot oil and deep frying it at 180°C to 200°C until the product turns golden brown colour. After frying, the products were kept in an airtight container to prevent it from deteriorate by moisture or other elements that may cause unacceptable taste and reduce crispiness.

Table 1: Standardization for formulation of composite flour

S. No.	Flour	Composition of Composite flour			
		Control	A	B	C
1	Chickpea flour	50	50	50	50
2	Oat flour	---	10	15	20
3	Soybean flour	---	10	15	20
3	Rice flour	50	30	20	10

Preparation of Extruded Snack Food

Composite flour

↓

Mixing thoroughly in bowl

↓

Addition of Spice mix

↓

Mixing with Composite flour

↓

Addition of sufficient amount of water

↓

Preparation of Dough

↓

Filling dough in Hand Molder

↓

Extruding the product in hot oil (temp. 200°C)

↓

Frying of product till golden brown color

↓

Air Tight Packaging of product

Flow sheet 1: Process for Preparation of Extruded Product

Nutritional analysis
Nutritional analysis for moisture content, crude protein content, crude fat, ash were determined by standard procedure given by AOAC (2002) [2], while Total carbohydrate was determined by standard procedure using phenol and sulphuric acid AOAC (1990) [1].

Sensory evaluation of product
The sensory assessments was carried out by panel of 25 members consisted of staff and post graduate students of the College of Food Technology, VNMKV, Parbhani. Sensorial evaluation was by done by using 9-point hedonic scale (Meilgaard, *et al.* 1999) [9].

Results and Discussion
The present investigation entitled was carried to explore the possibilities of enhancing the nutritional value of extruded snack using oat and soybean flour and to observe its effect on sensory and nutritional properties. The results obtained during present investigation are presented under different suitable headings.

Proximate composition snack food ingredients
Proximate composition generally represents the nutritional quality of different flours. It is necessary to observe the proximate composition of various flours to be used in extruded snacks preparation to judge its effect on final product quality. The proximate composition of major ingredients viz. rice flour, oat flour, soy flour and chickpea flour are represented in Table-2.

Table 2: Proximate composition of different ingredients used for extruded product preparation

Name	Moisture (%)	Crude Fat (%)	Crude Protein (%)	Ash (%)	Crude Fiber (%)	Carbohydrate (%)
Rice flour	11.39	1.21	7.53	1.01	0.34	77.2
Oat flour	10.70	7.50	13.70	1.75	3.57	62.73
Soybean flour	9.75	19.75	40.73	4.19	3.25	22.51
Chickpea	9.81	5.38	17.25	1.65	3.91	60.56

* Each value represents the average of three determinations

It can be clearly seen from Table-2 that the great variation exist in various constituents among the flours to be used in making the extruded snacks. Amongst all the ingredients, soy flour were found to contain highest amount of fat (19.75 per cent) while the lowest fat content was observed in rice flour (1.21 per cent). With respect to protein, the protein content of soybean flour, chickpea flour, oat flour and rice flour was found to be 40.73, 17.25, 13.70 and 7.53 per cent respectively.

The results pertaining to protein content revealed that incorporation of soybean may increase overall protein of extruded product. Highest value for ash was found in soybean flour while rice flour was found to contain lowest ash per cent amongst the investigated ingredients. Crude fiber content of chickpea, oat, soybean and rice was found to be 3.91, 3.57, 3.25 and 0.34 per cent respectively. The results with respect to the composition of soybean flour are comparable with the earlier reported values (Pollock and Geddes, 1960) [11]. Nearly similar values for rice (Ding *et al.*, 2005) [4], chickpea (Gopalan *et al.*, 2011) and oat flour (Hahn *et al.*, 1990) [7] were reported earlier.

Sensory evaluation of extruded products
The panel of semi-trained judges consisting of 25 members was given the extruded snack food samples for evaluation of organoleptic characteristics *viz.* colour, taste, flavour, texture and overall acceptability. It was served to judges on the day of preparation. The average sensorial score recorded by judges on hedonic scale was depicted in Table-3 and discussed under suitable quality attributes.

Table 3: Mean sensory score values for the Extruded snack food

Sample	Color	Flavor	Taste	Texture	Overall acceptability
Control	9.00	8.50	8.0	8.50	8.50
A	8.30	8.40	8.30	8.30	8.30
B	8.00	8.20	8.00	8.00	8.00
C	7.50	7.00	7.50	7.00	7.50
Mean	8.2	8.025	7.95	7.95	8.075
SE±	0.237	0.445	0.237	0.400	0.237
CD at 5%	0.711	0.999	0.711	0.991	0.711

* Each value represents the average of ten determinations

It may be visualized from Table-3, that composite flours exhibited differences with regard to colour character of final product ranging from 7.50 to 9.00. The color of Control sample was more acceptable (9.00) followed by samples A (8.50) and both were rated between like extremely to like very much. In regard to flavour, the flavor character of sample A was comparable with control. The taste quality characteristics of snack food was found to be increased in sample A followed

by decrease in taste with increasing concentrations. The textural quality of product decreased with increase in concentration of functional ingredients.

It is seen from the results that variation do exists in overall acceptability score. All the combinations of flours in composite flour valued in between like moderately to like very much. Highest score was observed in sample-A. It was interesting to note that the both Control sample and sample C scored same i.e. 7.50. The overall acceptability of extruded snack food could be attributed to the different characters of colour, taste, flavour and texture of the final product.

Nutritional composition of prepared extruded snacks
Snack food is generally considered as unhealthy food due to high carbohydrate and fat content with lower amount of crude fiber. During present investigation, the efforts were made to enhance the nutritional quality of extruded snack food by using soybean and oat flour in replacement of rice flour. The nutritional composition of all the samples with control was analyzed and the results are reported in Table-4.

Table 4: Nutritional Composition of Extruded snack

Nutrient Parameters	Control	Sample-A	Sample-B	Sample-C
Moisture (%)	6.51	6.57	6.61	6.69
Carbohydrate (%)	72.13	64.01	59.33	54.11
Crude Protein (%)	12.91	16.3	18.15	20.49
Crude fat (%)	6.1	8.01	10.16	11.29
Calorific value kcal/100 g	395.06	*413.82*	437.36	400.01
Crude Fiber (%)	1.18	2.59	3.02	3.31
Ash (%)	1.02	1.57	1.72	2.09

* Each value was an average of three determinations

The results revealed from Table-4 that carbohydrate content was drastically reduced from 72.12 per cent for control to 54.51 per cent with increase in concentration of multigrain. With respect to protein content, it could be clearly observed that the protein content of sample increase from 12.91 per cent to 20.49 per cent. The values of crude fiber content almost tripled from control to sample-C. Fat content of sample also increased from 6.1 to 11.29 per cent. The increase in fat content may be due to increased crude fiber and protein content which increased the absorption of fat in final product. In all it could be concluded that incorporation of soy and oat flour in extruded product resulted in increase in moisture, protein, fat, crude fiber and ash content while decreased the total carbohydrate content. The calorific value of Extruded Snacks shows that sample-B (437.36 kcal) gives maximum calories as compare to other samples i.e. control (395.06) sample-A (413.82) and sample-C (400.01), similar trendswere reported by Guria (2006) [6].

Conclusion
In the light of the scientific data of the present investigation, it may be concluded that the extruded snacks prepared from composite flour (Chickpea, Oat, Soybean and Rice flour in the ratios of 50: 10: 10: 30 respectively) was found to be more acceptable with respect to mentioned sensorial quality parameters and incorporation of oat and soybean flour in the snack food increased its nutritional value.

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