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STANDARDIZATION AND QUALITY EVALUATION OF READY TO EAT EXTRUDED SNACKS DEVELOPED USING MAIZE-OAT BLENDS AND PROCESSED COWPEA

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This study was aimed to standardize feed compositions (maize and oat) for the development of RTE extruded snacks and to evaluate physical, proximate and sensory characteristics of ready-to eat value added extruded snacks. Formulation containing maize and oat (90:10), at 12% moisture and 11 Kg/hr feed rate was selected for standardization. For the preparation of value added ready to eat extruded snacks 10, 20, 30, 40 and 50% of cowpea flour, 5, 10, 15, 20 and 25% of cowpea protein concentrate and 2, 4, 6, 8 and 10% cowpea protein isolates were incorporated in optimized formulation. Bulk density, expansion ratio, sectional expansion index and hardness of control extrudates prepared using maize and oat (90:10) were 0.059 g/cc, 3.82, 14.96 and 5.91 kg. Higher the level of cowpea flour, cowpea protein concentrates and isolates in the formulation, lower was the expansion ratio and sectional expansion index whereas higher was the bulk density and hardness of extrudates. Incorporation of cowpea flour (50%), cowpea protein concentrates (25%) and cowpea protein isolates (10%) improved protein content of RTE snacks by 53, 107 and 62.6%. As a result, processed cowpea can be successfully incorporated in maize and oat blend for preparation of value added RTE snacks without affecting the sensory quality.

Keywords: Extrudates, Maize, Oat, Cowpea, Concentrates, Isolates

INTRODUCTION

The present day economic scenario, emerging globalization and growing consumerism have changed the perception of food. Most of the consumers demand convenient and ready to eat food or snacks which add to bulk and satisfy their appetite. The term snack is used for a very heterogeneous group of food products varying in composition, shape and size. The role of snacks is to provide a light, convenient and enjoyable food options in between the principle meals. The diet consumed by majority of people in India are deficient in proteins, minerals etc. Baked and fried snacks are rich in fats and starch. Nutrition awareness and public education have increased the demand for low fat food. Product prepared by using single crop cannot fulfil the nutritional requirement. To accomplish it there is a need for suitable ingredients which are non-toxic, cost effective and able to meet the nutritional needs of consumers.

Cereals like rice, wheat, maize, oat and barley are used for preparation of breakfast cereals and snacks. Maize is a typical staple food: high in carbohydrates, moderate in protein, low in fat. Carbohydrates are absolutely needed for survival. Protein is the next most necessary macronutrient. Ordinary maize has too little protein and specifically too little lysine. Quality Protein Maize (QPM) is an improved

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form of maize developed in the late 19802s, but only now becoming widespread in cultivation. Quality Protein Maize (QPM) has more of the essential amino acids lysine and tryptophan, ample amounts of methionine, and a better distribution of its total protein among various essential amino acids, resulting in a better 'bioavailability", i.e., a more efficient use of the protein by the human body.

Oat (*Avena sativa L.*), normally consumed as a whole grain, are an excellent source of dietary fiber, β-glucan is a predominant component of starchy endosperm and aleurone cell walls of oat seeds. The typical β-glucan content reported for domestic *A. sativa* cultivars ranged from 3.7 to 5.0% on a dry matter basis (Mason, 2011). Oat is the only cereal containing a globulin or legume-like protein, avenalin. Typical cereal protein like gluten and zein are also present in oat. The discovery of the healthy cholesterol-lowering properties has led to wider appreciation of oats as human food.

Manufacturing of extruded products has great scope in the food processing sector as these products are convenient to use and covers a wide range of food products. Extrusion cooking is an emerging technology, a High-Temperature Short-Time (HTST) process. It is a process, which combines several unit operations including mixing, cooking, kneading, shearing, shaping and forming (Battacharya and Prakash, 1994). Extrusion has several effects on the nutritional properties of the resulting extruded products. Improvements in the protein and starch digestibility of extruded faba and kidney beans were reported by Alonso *et al*. (2000).

Snacks made exclusively from cereals are deficient in some amino acid viz. lysine and tryptophan. This can be enhanced by using processed legumes as legumes are rich sources of these essential amino acids. Judicious mixture of plant food like cereals and pulses particularly underutilized can be relatively inexpensive and at the same time can provide a mixture of protein with nearly as good amino acid pattern as that of expensive animal foods. Cowpea is a good source of protein, fiber and minerals (Kaur, 1986; Sharma and Sehgal, 1991a, 1991b, 1992a and 1992b). But cowpea is endowed with anti-nutritional factors such as trypsin inhibitor, lectin, phytic acid etc. These anti-nutritional factors could be decreased or destroyed by appropriate processing (Grewal, 1992). Alternatively, concentrates and isolate of protein can be prepared as during the process of formation of protein concentrates and isolates levels of anti-nutritional factors get reduced significantly. High percentage of protein in soy concentrates (65-72%) and soy isolate (90%) and low anti-nutritional factors have been documented. Incorporating underutilized legumes after processing and particularly in forms of concentrates and isolates in ready to eat snacks may be one of the approaches to utilize the agri-produce effectively.

MATERIALS AND METHODS

The study was carried out in the Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar. Maize variety HPQM-7 was procured from the Regional Research Station, *Uchani*, Karnal. Oat and cowpea was procured from the Department of Genetics and Plant Breading, CCS HAU, Hisar. The procedures for the development of cowpea flour, cowpea protein concentrates and cowpea protein isolates have been explained through Figure 1-3.

Standardization of Process and Composition

Response Surface Methodology (RSM) software dxt trial 8.01 version, was used to investigate the effect of extrusion condition on extrusion behavior and product characteristics. The main advantage of RSM was that it reduced number of experimental runs needed to provide

Figure 1: Process for Preparation of Cowpea Flour

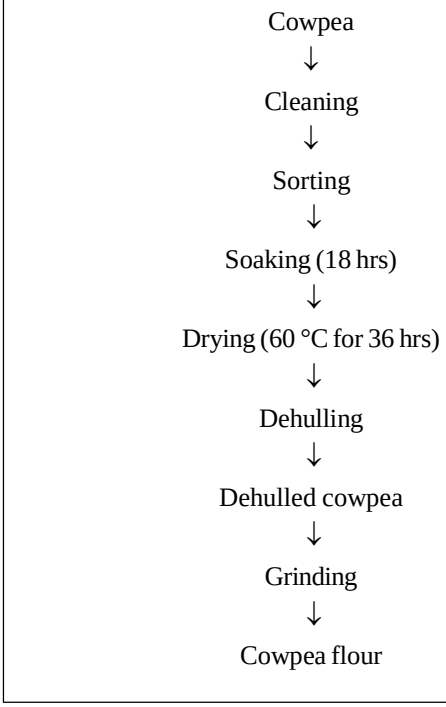


Figure 2: Process for Preparation of Cowpea Protein Concentrate

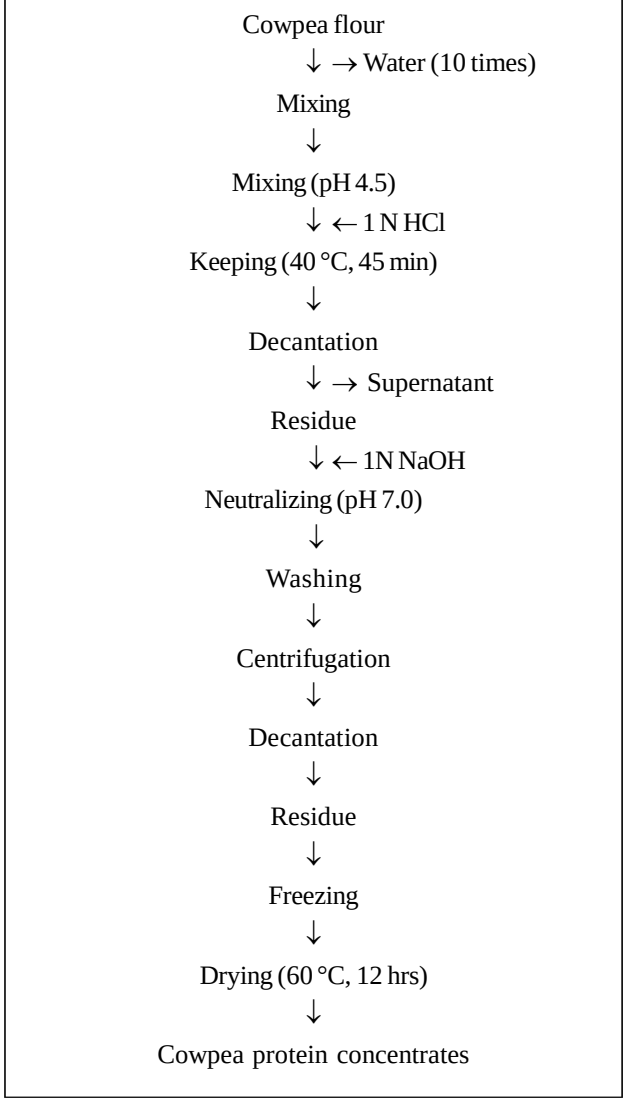
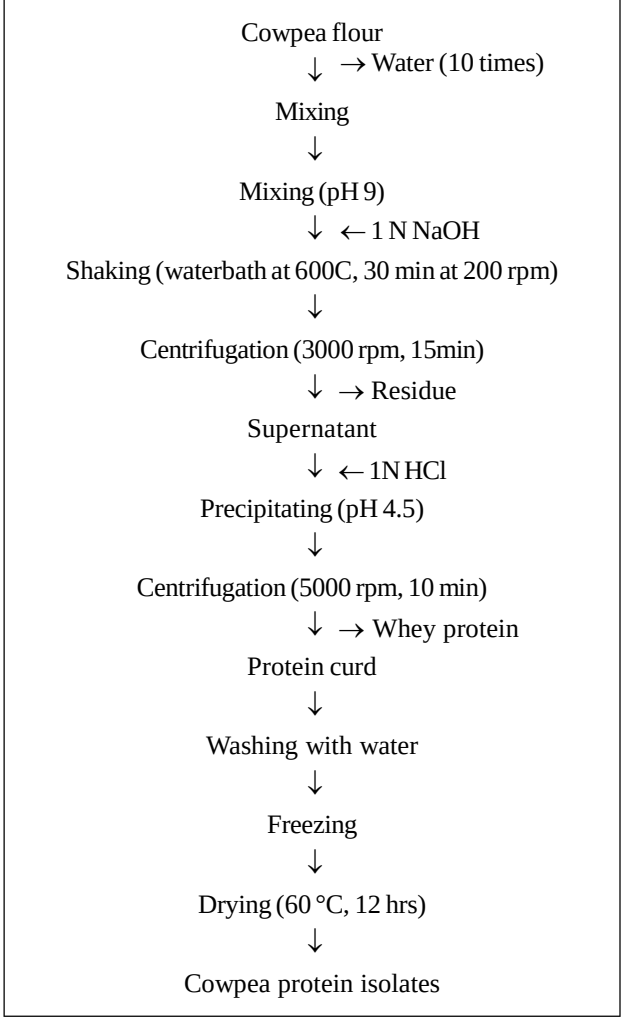


Figure 3: Process for Preparation of Cowpea Protein Concentrate



sufficient information for statistically acceptable results. A suitable Central Rotatable Composite Design (CRCD) was used. The independent variables included the moisture content (10-18%), Feed rate (9-17 kg/hr) and feed composition, i.e., maize: oat (100: 0, 90:10, 80:20, 70:30, 60:40 and 50:50). Response variables studied were bulk density, expansion ratio, Sectional Expansion Index (SEI), texture and overall acceptability. The optimum condition for the development of extruded ready to eat snack prepared with maize, and oat that product should get the maximum score in sensory characteristics, maximum expansion and sectional expansion index, minimum bulk density and hardness. Formulation containing maize and oat (90:10), at 12% moisture and 11 Kg/hr feed rate was selected for standardization (Table 1).

Preparation of Ready to Eat Value Added Extruded Snacks

For the preparation of value added ready to eat extruded snacks 10, 20, 30, 40 and 50% of cowpea flour, 5, 10, 15, 20 and 25% of cowpea protein concentrate and 2, 4, 6, 8 and 10% cowpea protein isolates were incorporated in optimized formulation for extruded snacks prepared with (90:10) maize and oat flour.

Quality Evaluation of Ready to Eat Extruded Snacks

The extrudates with or without incorporation of cowpea flour, cowpea protein concentrate and cowpea protein

Table 1: Physical and Sensory Characteristics of RTE Snacks Prepared Using Different Feed Compositions (Maize and Oat), Feed Rate and Moisture Level

Number	Feed Rate (Kg/hr)	Moisture Content (%)	Composition* (%)	Bulk Density	Sectional Ratio	SEI	Texture	Overall Acceptability
1	13	17	80:20:00	0.078	3.25	10.56	7.77	7.66
2	16	14	80:20:00	0.075	3.34	11.16	7.1	7.88
3	15	16	90:10:00	0.068	3.53	12.46	6.42	8.16
4	13	14	80:20:00	0.061	3.66	13.4	5.99	7.91
5	13	14	80:20:00	0.062	3.62	13.32	7.15	7.91
6	11	12	70:30:00	0.065	3.64	13.25	5.21	7.57
7	11	16	90:10:00	0.063	3.68	13.54	7.61	7.66
8	13	14	80:20:00	0.068	3.6	12.96	7.24	7.91
9	13	14	80:20:00	0.066	3.55	12.6	7.2	7.91
10	**11**	**12**	**90:10:00**	**0.059**	**3.82**	**14.44**	**5.91**	**7.83**
11	15	16	70:30:00	0.081	3.19	10.18	6.58	7.57
12	11	16	70:30:00	0.077	3.28	10.76	6.45	7.1
13	13	14	97:03:00	0.065	3.63	13.18	4.64	8.16
14	15	12	90:10:00	0.061	3.74	13.99	6.01	7.21
15	13	11	80:20:00	0.064	3.71	13.76	5.32	7.69
16	15	12	70:30:00	0.073	3.4	11.56	5.36	7.47
17	13	14	63:37:00	0.079	3.16	9.96	5.99	7.08
18	13	14	80:20:00	0.065	3.64	13.25	7.1	7.91
19	10	14	80:20:00	0.063	3.71	13.76	6.61	7.55
20	13	14	80:20:00	0.062	3.63	13.18	7.05	7.91

Note: * Maize: oat.

isolates were assessed for their physical properties viz. expansion ratio, sectional expansion index, bulk density and texture (hardness). The expansion ratio was determined according to the method of Harper (1981). The cross-sectional diameter of extrudates and that of die opening of the extruder were determined using vernier caliper. The expansion ratio was calculated as the ratio of diameter of extrudates to that of die. It was calculated by dividing the cross sectional areas of the extrudate (De) by the cross sectional areas of the die opening (Dd).

The bulk density was determined according to the method of Park *et al.* (1993). One hundred pieces of extrudates (about 2 cm in length) were placed in a 500ml graduated cylinder. The bottom of the cylinder was tapped gently on a laboratory bench until there was no further reduction in sample volume. The volume and weight was noted and bulk density was calculated by dividing weight of sample to volume. Texture of ready to extruded snacks was assessed using TAXT plus Texture analyzer in triplicates using 35 mm cylinder probe (CP/35) with 5 Kg load cell. The force required to break the extruded snacks was considered as hardness of snacks.

Extrudates were given auxiliary treatment with spice mixture. Extrudates were evaluated for color and appearance, aroma, texture, taste using 9-point Hedonic scale by a panel of ten semi-trained judges. Average of the scores for all the sensory characteristics was expressed as over all acceptability score.

The contents of protein, fat, crude fibre and ash in the developed RTE snacks were analysed using AOAC (2000) methods.

Statistical Analysis

The data was analyzed by Response surface methodology for standardization process and ANOVA using CRD for value added ready to eat snacks.

RESULTS

Physical and Sensory Characteristics of RTE Extruded Snacks

Bulk density, expansion ratio, sectional expansion index, hardness and overall acceptability of extrudates ranged from 0.061 to 0.081 g/cc, 3.16 to 3.82, 9.96 to 14.44 mm, 4.64 to 7.77 Kg, 7.08 to 8.16, respectively.

The results indicate that minimum bulk density was observed with formulation containing 80% maize extruded at 14% moisture content and 13 kg/hr feed rate same value of bulk density was observed with formulation containing 90% maize extruded at 12% moisture content and 15 kg/hr feed rate and maximum value was observed for formulation containing 70% maize, 30% oat extruded at 16% moisture content with 15 kg/hr feed rate. Further, formulation containing 63% maize, 37% oat extruded at 14% moisture content and 13 kg/hr feed rate showed minimum expansion ratio whereas formulation containing 90% maize, 10% oat extruded at 12% moisture content with 11 kg/hr feed rate maximum value was observed. In addition to highest expansion ratio this combination also had lowest bulk density and highest sectional expansion index. The extrudates prepared with formulation containing 63% maize, 37% oat 14% moisture content and 13 Kg/hr feed rate were adjudged as “liked moderately”. Whereas the extrudates prepared from 90% maize, 10% oat extruded at 16% moisture content with 15 kg/hr feed rate and formulation containing 97% oat, 3% oat at 14% moisture content and 13 kg/hr feed rate were assigned highest overall acceptability scores as a result product was “liked very much” by the judges (Table 1). Formulation containing maize and oat (90:10), at 12% moisture and 11 Kg/hr feed rate was selected for standardization.

Based on RSM proportion of maize and oat, 90:10 was found to be the best and was used for further value addition. Bulk density, expansion ratio, sectional expansion index and hardness of control extrudates prepared using maize and oat (90:10) were 0.059 g/cc, 3.82, 14.96 and 5.91 kg (Table 2).

Table 2: Physical Characteristics of Ready-to Eat Value Added Extruded Snacks

		Bulk Density (g/cc)	Expansion Ratio	Sectional Expansion Index	Texture (kg)
Control	0	0.059±0.002	3.82 ± 0.02	14.96±0.4	5.91 ±
Cowpea flour	10	0.061±0.003	3.10±0.003	9.61±0.5	8.21±0.44
	20	0.063±0.003	3.08±0.006	9.49±0.5	8.41±0.12
	30	0.068±0.002	3.06±0.003	9.36±0.5	8.80±0.03
	40	0.073±0.002	3.04±0.003	9.24±0.5	9.17±0.17
	50	0.075±0.001	3.02±0.007	9.12±0.2	9.25±0.35
CD at 5%		**0.006**	**0.026**	**0.86**	**0.76**
Control	0	0.059±0.002	3.82±0.02	14.96±0.4	5.91±0.012
Cowpea concentrates	5	0.069±0.000	3.05±0.003	9.30±0.5	7.82±0.026
	10	0.072±0.002	3.03±0.000	9.18±0.5	7.96±0.029
	15	0.073±0.001	3.00±0.000	9.00±0.5	8.10±0.017
	20	0.074±0.001	2.97±0.006	8.82±0.5	8.23±0.023
	25	0.076±0.001	2.95±0.003	8.70±0.2	8.34±0.025
CD at 5%		**0.004**	**0.024**	**0.86**	**0.86**
Control	0	0.059±0.002	3.82±0.02	14.96±0.4	5.91±0.012
Cowpea isolate	2	0.072±0.001	2.97±0.006	8.82±0.5	7.72±0.133
	4	0.075±0.001	2.92±0.006	8.53±0.5	7.79±0.113
	6	0.077±0.011	2.89±0.003	8.35±0.5	8.02±0.075
	8	0.079±0.001	2.87±0.003	8.24±0.5	8.12±0.055
	10	0.080±0.001	2.83±0.010	8.01±0.2	8.28±0.047
CD at 5%		**0.004**	**0.028**	**0.86**	**0.86**

Note: Values are mean ± S.D of three replicates.

Bulk density and hardness of ready to eat extruded snacks increased and on the contrary expansion ratio and sectional expansion index decreased gradually with increase in level of cowpea flour in maize and oat blend. As a result RTE snacks prepared with 50% cowpea flour were more dense and harder.

Similar trend in physical characteristics of extrudates prepared by incorporation of cowpea protein concentrates and isolates in maize and oat blend (90:10) was noticed. Extrudates with higher amount of cowpea protein concentrates and isolates were found to have higher bulk density and hardness. Whereas expansion ratio and sectional expansion index was lower at higher level of protein concentrates and isolates in the formulation.

Higher the level of cowpea flour, cowpea protein concentrates and isolates in the formulation, lower was the

Table 3: Sensory Characteristics of Ready-to Eat Value Added Extruded Snacks

Level of Supplementation %	Color and Appearance	Taste	Texture	Aroma	Over all Acceptability
Cowpea Flour					
0	8.3 ± 0.16	8.5 ± 0.19	8.3 ± 0.21	8.0 ± 0.00	8.3 ± 0.16
2	8.3 ± 0.16	8.5 ± 0.19	8.0 ± 0.00	7.8 ± 0.16	8.2 ± 0.13
4	8.1 ± 0.12	8.3 ± 0.16	8.0 ± 0.00	7.6 ± 0.18	8.0 ± 0.13
6	8.0 ± 0.00	8.0 ± 0.00	7.8 ± 0.17	7.5 ± 0.19	7.8 ± 0.16
8	7.8 ± 0.16	7.6 ± 0.18	7.5 ± 0.17	7.4 ± 0.18	7.6 ± 0.12
10	7.6 ± 0.18	7.5 ± 0.19	7.3 ± 0.21	7.3 ± 016	7.4 ± 0.18
CD at 5%	0.42	0.48	0.52	0.46	0.48
Cowpea Protein Concentrates					
0	8.3 ± 0.16	8.5 ± 0.19	8.3 ± 0.16	8.0 ± 0.00	8.3 ± 0.16
5	8.1 ± .013	8.3 ± 0.16	8.1 ± 0.13	7.9 ± 0.13	8.1 ± 0.13
10	8.0 ±0.00	8.1 ± 0.13	8.0 ± 0.00	7.8 ± 0.16	8.0 ± 0.18
15	7.8 ± 0.16	7.6 ± 0.18	7.8 ± 0.16	7.5 ± 0.19	7.6 ± 0.19
20	7.4 ± 0.18	7.5 ± 0.19	7.3 ± 0.16	7.3 ± 0.16	7.4 ± 0.17
25	7.3 ± 0.16	7.1 ± 0.13	7.0 ± 0.00	7.1 ± 0.13	7.1 ± 0.16
CD at 5%	0.42	0.47	0.36	0.41	0.44
Cowpea Protein Isolates					
0	8.3 ± 0.16	8.5 ± 0.19	8.3 ± 0.21	8.0 ± 0.00	8.3 ± 0.16
2	8.3 ± 0.16	8.5 ± 0.19	8.0 ± 0.00	7.8 ± 0.16	8.2 ± 0.13
4	8.1 ± 0.12	8.3 ± 0.16	8.0 ± 0.00	7.6 ± 0.18	8.0 ± 0.13
6	8.0 ± 0.00	8.0 ± 0.00	7.8 ± 0.17	7.5 ± 0.19	7.8 ± 0.16
8	7.8 ± 0.16	7.6 ± 0.18	7.5 ± 0.17	7.4 ± 0.18	7.6 ± 0.12
10	7.6 ± 0.18	7.5 ± 0.19	7.3 ± 0.21	7.3 ± 016	7.4 ± 0.18
CD at 5%	0.42	0.48	0.52	0.46	0.48

Note: Values are mean ± S.D. of eight replicates.

expansion ratio and sectional expansion index whereas higher was the bulk density and hardness of extrudates. As a result, the RTE snacks prepared with 50% incorporation of cowpea flour were dense and hard. Similarly RTE snacks prepared with 25% protein concentrates and 10% protein isolates were harder and denser.

On the basis of mean score of overall acceptability the value added RTE snacks prepared with incorporation of cowpea flour up to 20% in maize and oat blend (90:10) were liked very much to extremely liked by the judges. Further increase in level of cowpea flour in maize and oat blend, decreased the mean scores for color, appearance, taste, texture and aroma. As a result decrease in mean score for overall acceptability was witnessed. However, mean score for overall acceptability of RTE snacks prepared with 50% level of incorporation of cowpea flour showed that the products were "moderately liked" by judges. As a result, cowpea flour can be added upto 50% in maize and oat flour to prepare RTE snacks, without much affecting the sensory characteristics. RTE snacks prepared by incorporating cowpea protein concentrate upto 10% in maize and oat blend were "liked very much" by judges. Further increase in level of cowpea protein concentrate in maize and oat blend reduced the mean score for sensory attributes of RTE-snacks. However, RTE snack with prepared 25% level of incorporation of cowpea protein concentrates in maize and oat blend were "liked moderately" by judges. As a result the RTE snacks can be prepared by incorporating upto 25% cowpea protein concentrates in maize and oat blend without much affecting the sensory parameters. Sensory evaluation of RTE-snacks showed that extrudates containing upto 4% of cowpea protein isolates were liked very much to liked extremely by the judges. Incorporation of cowpea protein isolates beyond 4% in maize oat blend decreased the mean scores for overall acceptability of extrudates. RTE snacks prepared by using maize and oat blends containing upto 10% of cowpea protein isolates were also liked moderately to liked very much by judges. So, cowpea protein isolates can be incorporated upto 10% level in maize and oat blend to prepare RTE snacks without much affecting the sensory quality of extrudates.

RTE extruded snacks prepared by using maize oat blend were found to contain 11.2% crude protein, 4.3% crude fat, 1.5% ash, 2.4% crude fibre and 80.7% carbohydrates per 100 g and ready to eat extruded snacks prepared by using maize and oat flour 90:10 contained 11.5% crude protein, 4.6% crude fat, 1.8% ash, 2.2% crude fibre and 79.9% carbohydrates per 100 g (Table 4). Incorporation of pulse

Table 4: Proximate Composition of Ready-to Eat Value Added Extruded Snacks (g/100 g)

	Crude Protein	Crude Fats	Ash	Crude Fibre	Carbohydrates
Control (Maize oat; 90:10)	11.5	4.6	1.8	2.2	79.9
Cowpea flour 50%	17.6	4.3	2.9	2.2	73
Cowpea concentrates 25%	23.9	3.7	2.4	2	68.7
Cowpea isolates 10%	18.7	3.4	2.8	2.6	72.3

Note: Values are mean ± S.D. of three replicates.

flour in the maize oat blend used to prepare the value added extruded snacks, increase the amount of protein in RTE snacks whereas no appreciable change was observed in amount of crude fat, ash and crude fibre. Protein content of value added extruded snacks prepared by incorporating 50% pulse flour, 25% pulse protein concentrates and 10% of pulse protein isolates was 17.6 g, 23.9 g and 18.7 g, respectively.

DISCUSSION

Control and experimental RTE extracted snacks were evaluated for physical and sensory characteristics and results indicated that increase in level of cowpea flour in the maize and oat blend decreased the expension ration and sectioinal expansion index of extraduties, whereas increase in bulk density and hardness of extrudates was observed. It may be due to reduced expansion properties of blend containing pulse flour as compared to maize and oat blend. As a result, the RTE snacks prepared with 50% cowpea flour were dense and hard. Lower extrudates expansion may be due to the higher protein content of cowpea flour. The relation of protein to expansion has been reported by Khalid *et al*. (2012). More the protein less be the expansion. Extradates density is inversely related to overall product expansion. Similarly with the incorporation of cowpea protein concentrates and isolates in maize oat blend bulk density and hardness of extrudates increased, whereas sectional expansion index and expansion ratio decreased. Poonam *et al*. (2015) prepared ready-to-eat snacks incorporating various levels of different pulse flour to the mixture of wheat flour and maize and analyzed the expansion ratio, bulk density and hardness of RTE-Snacks. The expansion ratio, bulk density and hardness of RTE-Snacks without replacement (control sample) were 9.02, 0.06 and 5.17 kg, respectively. A gradual decrease in expansion ratio and increase in bulk density and hardness of extrudates was noticed with every 5% increase in soybean flour in the formulation of RTE-Snacks. Similar trends were observed in the RTE-snacks prepared from green gram flour. Shadan *et al.* (2014) formulated, prepared and evaluated the low-cost extrude products prepared from composite flour of corn flour, rice flour and germinated or non germinated cow pea flour, chickpea flour and green gram flour in the different ratios. The bulk density of the extrudates (A) prepared using only corn (control) was lowest (0.16 cm^2) while it was highest (0.23 cm^2) in the extrudates (C) prepared using corn, rice, chickpea and green gram followed by the extrudates (F; 0.22 cm^2) prepared using corn, rice, germinated cowpea, germinated chickpea and green gram, extrudates (E; 0.21 cm^2) prepared with corn rice, germinated and non germinated chickpea, extrudates (B; 0.20 $cm^{2)}$ prepared with corn, rice, cowpea, green gram and extrudates (D; 0.18 cm^2) prepared using corn, rice and germinated or non germinated cowpea. Although increase in the protein content is a reason for decreasing of the bulk density in extruded products but our finding showed an increase in the bulk density in the extruded products with higher content of protein. It may be related to their content of their crude fiber, because it was higher in these products, Singh *et al.* (1996), Ruiz-Ruiz *et al.* (2008) and Deshpande and Poshadri (2011) reported that crude fiber has effect on the bulk density.

In present study, RTE snacks prepared by incorporating even 50% cowpea flour, 25% protein concentrates and 10% protein isolates were found to be acceptable on sensory basis. Thilagavathi *et al*. (2015) standardized extruded products using modified millet flour and pulse flour. Noodles prepared with wheat: millets: horse gram or soybean flour: egg white (50:30:10:10) exhibited smooth and firm texture with elasticity and less stickiness. The taste of the pasta products exhibited typical pasta. The mean value for overall organoleptic scores of developed extruded products were highly acceptable and in the range of 8.4-8.8. Comparison among the averages of sensory properties of six extruded products showed that, the mean scores of sensory evaluation extruded product F were significantly better in colour (7.2 ± 1.9), flavor (8.0 ± 1.8), texture (8.5 ± 1.0), and overall acceptability (7.9 ± 1.8) than others. The results indicated that, the composite flour F that contain; corn, rice, cowpea (germinated), chickpea (germinated), green gram, cowpea (un-germinated), chickpea (un-germinated) in the ratios of 55:10:10:10:5:5:5 respectively, could be used to produce quality extruded with acceptable sensory properties (Shadan *et al.*, 2014).

Results indicate that value added RTE snacks prepared by incorporation of cowpea flour (50%), protein concentrates (25%) and isolates (10%) contained 53%, 107% and 62.6% more protein than the control RTE snacks. Isolate are the most refined form of protein products containing the greatest concentration of protein but unlike flour and concentrates contains no dietary fibre. Pulse protein concentrates and isolates have been used to fortify all type of pasta products such as macaroni, spaghetti, to improve the nutritional value with special reference to protein (Sipos, 2013). Protein isolates and concentrates show a lot of potential to combat the problem of

Figure 4: Cow Pea Protein Concentrates (Left) and Isolates (Right)

Figure 5: RTE Snakes Prepared by Incorporating Cowpea Flour (10, 20, 30, 40 and 50%) (Left), Cowpea Protein Concentrates (5, 10, 15, 20, and 25%) (Center) and Cowpea Protein Isolates (2, 4, 6, 8 and 10%) (Right)

malnutrition. The cowpea an underutilised pulse can be exploited in order to extract the proteins and make them available for used as food supplements. A highly significant increase in protein content of wheat based noodles was observed with the incorporation of horse gram and soybean flour (Thilagavathi *et al*., 2015).

CONCLUSION

Higher the level of cowpea flour, protein concentrates and isolates in the formulation, lower was the expansion ratio and sectional expansion index whereas higher was the bulk density and hardness of extrudates. RTE snacks prepared with high quality maize- oat blends (90:10) incorporated with 50% of cowpea flour, 25% of protein concentrates and 10% of protein isolates were adjudged as liked moderately to liked very much by the judges and contained 53%, 107% and 62.6% more protein respectively than the control RTE snacks.

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