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Development and Sensory Evaluation of Extruded Snack from Composite Flour of Black Soybean and Finger Millet Fortified with Moringa Leaf Powder

Alka Singh[1], Neha Sahrawat[2], Manshi Tyagi[3], Neelam Chaturvedi[4]

Department of Food Science and Nutrition, Banasthali Vidyapith, Dist- Tonk, Rajasthan, India

Corresponding Author: Alka Singh

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ABSTRACT

The aim of the current study was to develop ready-to-eat snack employing extrusion cooking using composite flour made from black soybean and finger millet fortified with moringa leaf powder. The extruded puff was made using flour blends at different ratios, and semi-trained personnel assisted in conducting a sensory evaluation of the generated extruded products puff. Samples were evaluated on a 5-point composite scale for colour, appearance, texture, flavour, and taste, as well as a 9-point hedonic scale for overall acceptance. The ratio of finger millet flour, black soybean flour, moringa leaf powder and durum wheat flour for the three composite flour CF-1 and CF-2 and CF-3 was (20%, 10%, 2%, 68%), (15%, 15%, 42%, 68%) and (10%, 20%, 2%, 68%) respectively while 100% durum wheat flour was used as control. The Extruded Puff were collected and dried for one hour at 60^0C in a hot air oven tray dryer. After drying, the extruded puff was placed in airtight containers and left to cool until further examination. The results indicated that composite flour CF-3 (finger millet: black soybean; moringa leaf powder and durum wheat flour in the ratios of (10:20:2:68) could be used to produce quality extruded product puff with acceptable sensory properties and registered significant difference with each other at $p<0.05$ level.

Key words: Sensory Evaluation, Fortification, Black soybean, Finger Millet, Moringa Leaf Powder.

INTRODUCTION

In recent years, there has been a rise in interest in the manufacture of extruded meals, including snacks, pasta, breakfast cereals, baby food, and pet food (Yadav and Chandra, 2015). Extrusion cooking is a high-temperature, short-time (HTST) technology used in numerous food manufacturing processes and is regarded as a continuous cooking, mixing, and shaping process with great efficiency and low cost. An extruder is a thermodynamic device that uses heat, pressure, and mechanical shear in tandem. Screw and barrel tube mechanism is used to complete the procedure. The extruder barrel receives the feed material in granular form, which is subsequently conveyed, compressed, and sheared into a semi-solid plasticized mass. After that, to create a variety of forms, the food is extruded through an adjustable die using spinning knives or later guillotine knives. Cooking temperatures during extrusion could reach 180–190 °C, and residence times are typically 20–40 seconds. Extrusion is a food processing technique in which materials for feed are compelled to flow under one or more conditions such as mixing, heating, and shearing via a die that shapes and puff-dries the contents. Extrusion is cooking at a high temperature, pressure, and moisture (Saini *et al.*, 2018).
Legumes in general and cereals in particular are crucial for human nutrition. Recent studies have demonstrated that beans and

cereals include elements that are beneficial to human health, such as antioxidants and anti-disease factors (Ragaee *et al.,* 2006). Cereals constitute a sizable component of the human diet and are a significant source of starch and other dietary carbohydrates (dietary fibre), which are crucial to a person's need for energy and nutritional intake. For a major portion of the people living in millet-growing areas, which are thought to be the most disadvantaged groups, the millets' greater fibre content, protein quality, and mineral composition considerably contribute to nutritional security (Desai *et al.,* 2010). Legumes are believed to be beneficial for health due to their compatibility with cereals and their potential to prevent diseases including colon cancer, type 2 diabetes, obesity, and cardiovascular disease (Guillon and Champ, 2002).

Black soybean (*Glycine max*), also known as kalabhat, bhatt, or bhatmass, is a popular legume that is high in protein, iron, calcium, phosphorus, carbohydrate, and vitamins A and B (kwon *et al.,* 2007). It is the best, richest, and most affordable form of vegetable protein that is currently available to humans. Soybeans, with high polyunsaturated fat, high protein content and absence of cholesterol and lactose are a great source of the essential amino acids required for body growth, maintenance, and reproduction (Iwe, 2003).

Finger millet (*Eleusine coracana*), also known as Ragi, is an excellent source of dietary fibre, protein, vitamins (vitamin B complex, including thiamine, riboflavin, folic acid, and niacin), and minerals (magnesium, phosphorus and iron). It is a key staple food for individuals in poor socioeconomic groups (Jideani, 2012). The iodine level is believed to be the highest among all the food grains, while the calcium content is higher than all cereals. Consequently, ragi is a healthy food source for growing children, expectant women, elderly individuals, and patients (Desai *et al.,* 2010). Low fat content in finger millet lowers the risk of developing diabetes mellitus and gastrointestinal tract problems (Muthamilarasan *et al*., 2016).

Moringa leaves (*Moringa oleifera*), according to reports, contain higher amounts of calcium, potassium, iron, and proteins than foods like spinach, oranges, carrots, milk, bananas, and yoghurt. They also include higher amounts of vitamins C and A than those found in other foods (Gopalakrishnan, Doriya, & Kumar, 2016). The leaves of *Moringa oleifera* have long been used nutritionally to treat malnutrition in children, expectant women, and nursing mothers, as well as to help breastfeeding moms produce more milk (Fahey, 2005 and Saini *et al.,* 2014). Additional health benefits of *Moringa oleifera* include anti-inflammatory, anti- hypertensive, anti-spasmodic, an*ti*- tumour, anti-pyretic, anti-*ox*idant, anti-epileptic, anti-ulcer, diuretic, cholesterol lowering, anti-diabetic, renal, (Paliwal *et al.,* 2011; Sharma *et al.,* 2012) and hepatoprotective activities (Lai *et al.,* 2010; Huang *et al.,* 2012).

The purpose of present study was to develop and do sensory evaluation of a nutritionally rich, cost effective, easily available ready to eat food item by using composite flour which can be used to alleviate problem of malnutrition. This also shows that composite flour could be cheap and healthy alternative to commonly used durum wheat flour.

MATERIALS AND METHODS

This section explains the materials utilised, the techniques employed, the calculations made, and the variables taken into account when creating the extruded product using a twin-screw extruder.

2.1 Collection of raw material

Black soybean (*Glycine max* (L.) variety VL Soya-65, Finger millet (*Eleusine coracana*) variety VL Mandua-352 was procured from ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand and Drumstick leaf *(Moringa oleifera)* was collected from Division of Food Science and Postharvest Technology, ICAR-Indian

Agricultural Research Institute, Pusa, New Delhi.

2.2 Preparation of Seed Flours and Leaf Powder

Black soybean seed and Finger millet seed were cleaned and milled of using grinder sieved and stored in airtight container for further analysis whereas, Moringa leaf were washed and shaded dry in room temperature and milled using grinder, sieved and stored in airtight container.

Table 1: Preparation of Composite Flour in Different Proportions

S. No.	Flours	Proportion of composite flour samples			
		CF-1	CF-2	CF-3	Control
1	Finger millet flour	20	15	10	-
2	Black soybean flour	10	15	20	-
3	Moringa leaf powder	2	2	2	-
4	Durum wheat flour	68	68	68	100

2.3 Preparation of Extruded Products Puff

The different composite flour of Finger Millet Flour, Black soybean Flour, Moringa Leaf Powder and Durum Wheat Flour in different ratio of CF-1 (20%, 10%, 2%, 68%), CF-2 (15%, 15%, 2%, 68%), CF-3 (10%, 20%, 2%, 68%) respectively and Control (100% Durum Wheat Flour) was taken on a dry weight basis. The feed's moisture content was kept at 15% by adding calculated amount of water and mixing it in a mixer. These were subsequently put through a 2 mm screen to break up the lumps. The flour sample were placed in the polythene covers to achieve uniform mixing and to reduce feed material variability and the flour samples were equilibrated at room temperature for two hours before to extrusion. The Extruded products Puff have been prepared in Food Science Laboratory in ICAR, New-Delhi.

2.4 Twin Screw Extruder

A twin-screw extruder was used to extrude composite flour based puff (380 Volt-3 phase, Basic Technology Pvt Ltd, Calcutta). Extruded puff was prepared by using different composite flour CF-1, CF-2, CF-3 and Control (100% Durum Wheat Flour). The machine was left on for 30 minutes in order to maintain the desired temperature. The screw speed, temperature, cutter speed, moisture content and diameter of the die were maintained at 250-350 rpm (screw speed), 100-120˚C (temperature), 150 rpm (cutter speed), 16-20% (moisture content) and 3 mm die diameter respectively. The composite flour was fed into extruder slowly and continuously in order to avoid choking. The extruded puff was collected and dried in a hot air oven tray dryer for an hour at 60^0C and then dried Puff was kept in airtight containers at room temperature without any preservatives until further analysis.

2.5 Sensory Evaluation

Sensory evaluation indicates the acceptability of the product. A nine-point hedonic scale was used to evaluate the acceptability of the extrudate. The sensory evaluation of the developed products was conducted with the help of semi-trained personnel. Samples were evaluated for various attribute viz. colour, appearance, texture, flavour and taste on 5-point composite score and overall acceptability by 9-point hedonic scale. The extruded product's sensory examination found that the treatments for the organoleptic attributes varied significantly (Ranganna, 1995).

2.6 Statistical analysis

The results obtained were expressed as Mean±SD and Paired t-test of three determinations and also statistically analysed to ascertain its significance. The significance was estimated at ($p<0.05$ level).

RESULT AND DISCUSSION

3.1 Sensory Evaluation of Extruded Puff Prepared from Different Composite flour

The sensory evaluation of different composite flour based extruded product puff is shown in Table 2. The samples constituted of one control sample which was

developed from durum wheat flour while the other three samples were developed with composite flour at CF-1; 20:10 (FM: BS), CF-2; 15:15 (FM: BS) and CF-3; 10:20 (FM: BS) with 2% MLP and 68% DWF).

FM: Finger Millet, BS: Black soybean, MLP: Moringa Leaf Powder, DWF: Durum Wheat Flour.

Table 2: Organoleptic Evaluation Scores for the Acceptability of Puff Prepared from Different Composite flour

Composite flour	Organoleptic Attributes				
	Colour	Appearance	Flavour	Texture	Taste
Control	4.9±0.01	4.9±0.01	4.8±0.02	4.9±0.01	4.9±0.02
CF-1	3.1±0.35*	3.4±0.74*	3.8±0.67*	3.4±0.50*	3.9±0.70*
CF-2	4.4±0.63 ^{NS}	4.2±0.56 ^{NS}	4.6±0.61 ^{NS}	4.6±0.72 ^{NS}	4.1±0.74*
CF-3	4.7±0.45 ^{NS}	4.6±0.50 ^{NS}	4.8±0.74 ^{NS}	4.9±0.79 ^{NS}	4.9±0.70 ^{NS}

Data are reported as Mean±SD for groups of 30 panels each. *- Significant at p≤0.05 NS- Non-significant. All variants of extruded Puff; CF-1, CF-2 and CF-3, were compared to Control. CF-1; 20:10 (FM: BS), CF-2; 15:15 (FM: BS) and CF-3; 10:20 (FM: BS) with 2% MLP and 68% DWF). FM; Finger Millet, BS; Black soybean, MLP; Moringa Leaf Powder, DWF; Durum Wheat Flour

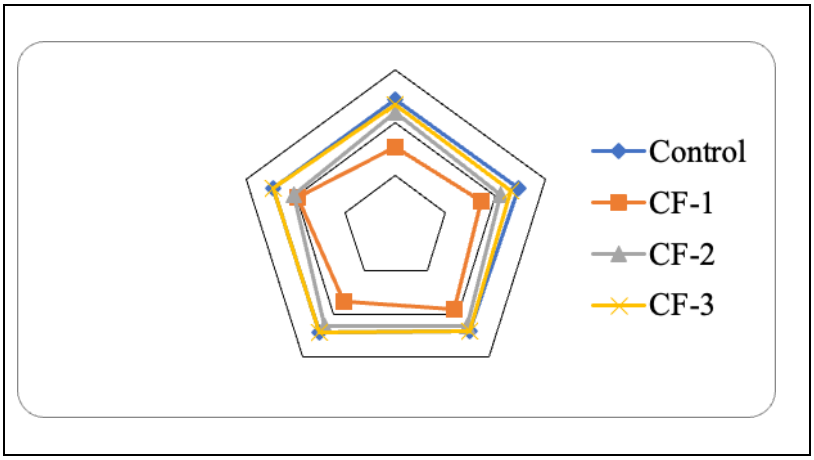

Figure 2: Organoleptic Evaluation of 'Puff' by Using 5- Point Composite Score

Result of the organoleptic Evaluation of the different composite flour based puff and control puff presented in Table 2 and Figure 2. The Mean ±SD of colour of different composite flour based puff; CF-1, CF-2 and CF-3 were 3.1±0.35, 4.4±0.63 and 4.7±0.45 respectively. Among all the composite flour based puff, CF-2 (4.4±0.63) and CF-3 (4.7±0.45) were insignificant at p≤0.05 level whereas CF-1 puff (3.1±0.35) found to be significant when compared to control puff (4.9±0.01) at p≤0.05 level. The Mean ±SD of appearance of different composite flour based puff; CF-1, CF-2 and CF-3 were 3.4±0.74, 4.2±0.56 and 4.6±0.50 respectively. Among all the composite flour based puff CF-2 (4.2±0.56) and CF-3 (4.6±0.50) were insignificant whereas CF-1 puff (3.4±0.74) found to be significant when compared to control puff (4.9±0.01) at p≤0.05 level. The Mean ±SD of flavour of different composite flour based puff; CF-1, CF-2 and CF-3 were 3.8±0.67, 4.6±0.61 and 4.8±0.74 respectively. Among all the composite flour based puff CF2 (4.6±0.61) and CF-3 (4.8±0.74) were insignificant whereas CF-1 puff (3.8±0.67) found to be significant when compared to control puff (4.8±0.02) at p≤0.05 level. The Mean±SD of texture of different composite flour based puff; CF-1, CF-2 and CF-3 were 3.4±0.50, 4.6±0.72 and 4.9±0.79 respectively. Among all the composite flour based puff CF-2 (4.6±0.72) and CF-3 (4.9±0.79) were insignificant whereas CF-1 puff (3.4±0.50) found to be significant when compared to

control puff (4.9±0.01) at p≤0.05 level. The Mean±SD of taste of different composite flour based puff; CF-1, CF-2 and CF-3 were 3.9±0.70, 4.1±0.74 and 4.9±0.70 respectively. Among all the composite flour based puff, CF-1 (3.9±0.70) and CF-2 (4.1±0.74) were significant whereas CF-3 puff (4.9±0.70) found to be insignificant when compared to control puff (4.9±0.02) at p≤0.05 level. Reddy *et al.*, (2014) reported that an incorporation of up to 20 percent of yam, beetroot and sweet potato in extruded product was organoleptically acceptable and also revealed that no statistically significant difference was found between control and extruded snacks. Deshpande and Poshadari, (2011) informed that the extruded product developed by using ratio of 60:20:10:05:05 of foxtail millet, channa, cowpea, rice and amaranth powder significantly found to have better texture, flavour, colour, appearance and overall acceptability. Kumar, (2013) investigated that an incorporation of up to 20 percent and 50 percent cowpea flour in the maize oat composite mixes for preparation of RTE extruded product fell in the category of liked very much and liked moderately.

Table 3: Organoleptic Evaluation for Overall Acceptability of Puff Prepared from Different Proportion of Composite flour

Composite flour	Overall Acceptability
	Puff
Control	8.9±0.00
CF-1	7.2±0.67*
CF-2	7.8±0.63*
CF-3	8.6±0.70^{NS}

Data are reported as Mean±SD for groups of 30 panels each. *- Significant at p≤ 0.05. NS-Non-significant. Data are reported as Mean±SD. All test composite flour based products-Puff; CF-1, CF-2 and CF-3, were compared to Control. CF-1; 20:10 (FM: BS), CF-2; 15:15 (FM: BS) and CF-3; 10:20 (FM: BS) with 2% MLP and 68% DWF). FM; Finger Millet, BS; Black soybean, MLP; Moringa Leaf Powder, DWF; Durum Wheat Flour

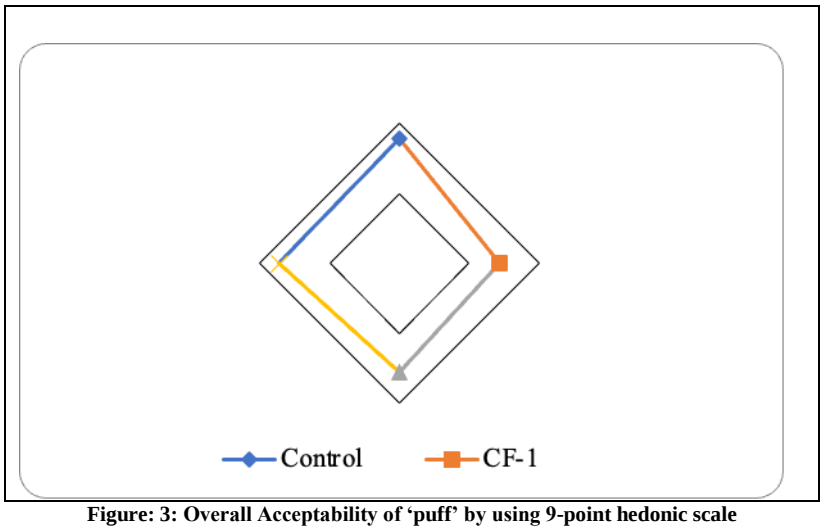

Figure: 3: Overall Acceptability of 'puff' by using 9-point hedonic scale

The Mean±SD value of score for overall acceptability of all three composite flour based Puff (CF-1, CF-2 and CF-3) and extruded products in the control Puff as shown in Table 3 and Figure 3. Overall acceptability was statistically different among three composite flour based puff when compared to control puff. The Mean±SD of overall acceptability of different composite flour based puff CF-1, CF-2 and CF-3 were 7.2±0.67, 7.8±0.63 and 8.6±0.70 respectively. The values of overall acceptability were significantly different in CF-1 and CF-2 puff at p≤0.05 level whereas CF-3 puff (8.6±0.70) showed insignificant value when compared to control puff (8.9±0.00) in terms of overall acceptability. Sahu & Patel, (2021) reported that the developed composite flour based on maize, finger millet, defatted soy and elephant foot

in the ratio of 40:30:20:10 have 7.8 over all acceptability on 9-Point Hedonic scale. The developed composite flour comprising germinated millets and roasted soybean recorded 7.05 of overall acceptability at 9-Point Hedonic scale according to Coulibaly *et al.*, (2012).

CONCLUSION

The present study concludes that extruded product puff derived from composite flour of black soybean and finger millet fortified with moringa leaf powder and durum wheat flour has shown enhancement of nutrient and has good potential to fight with malnutrition in children and is organoleptically acceptable. In value added products, the highest mean scores correspond to CF-3 puff for all sensory parameters. It can be concluded that extruded products could be successfully prepared by using finger millet in addition to black soybean and moringa leaf and it having good overall acceptability.

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