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Suitability of foxtail millet semolina and soy grits for the formulation of instant upma mix

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Abstract
The present study focused on the use of foxtail mill*et al*ong with soy grits for the preparation of instant upma mix. The instant upma mixes were evaluated for sensory characteristics, proximate composition, hunter colour values and cooking quality characteristics. Results of sensory evaluation showed that mix prepared from 75% foxtail millet, 20% wheat semolina and 5% soy grits was well accepted. The proximate composition of cooked upma exhibited moisture content from 37.50 to 40.60%, protein 11.20 to 12.90%, fat 6.38 to 8.14%, fibre 1.15 to 7.47%, ash 2.00 to 3.80%, carbohydrate content 59.87 to 70.16% and energy value 245.62 to 256.90Kcal/100 g. In Hunter colour analysis, the L* value was decreased with increasing level of foxtail millet semolina. The cooking time required by improved upma mix was higher as compared to control sample. Water uptake and rehydration ratio were found to be highest in formulation U6 prepared from 95% foxtail millet semolina and 5% soy grits whereas solids in cooking water was highest in formulation U4.

Keywords: Foxtail millet semolina, soy grits, instant upma mix, optimization

Introduction
Traditional foods have become the first preference of the consumers. Many cereal based traditional foods have been processed and their instant mixes like instant upma mix, idli mix and dosa mix have been developed. These ready-to-cook mixes are easily available to the consumers and also give the satisfaction of cooking by self but such mixes do not contain all the nutrients in a balanced form as they are prepared by using refined cereals and pulses which are deficient in essential macro and micronutriesnts (Arora *et al*., 2016) [5]. Upma is a traditional Indian breakfast dish, cooked as a thick porridge from dry roasted semolina. Semolina is a popular ingredient both in Asian and Western cuisines. Semolina from foxtail millet could be a new product from small millets, which can offer inherent health benefits associated with foxtail millet for the consumer and can also open up better avenues for utilization of millet products (Dharmaraj *et al*., 2016) [11].

Foxtail millet (*Setaria italica*) also called Italian millet or kangni, is one of the oldest cultivated cereal, with its origin in China and subsequently extending into India and most of Africa and parts of the Southern United States (Liu *et al*., 2012) [16]. It has good nutritional profile and is comparable to staple cereals as rice and wheat in terms of protein, fibre, minerals and vitamins but its potential role as low GI food has remained unrealized and unexploited. It has been proved to be suitable for people suffering from metabolic disorders (Itagi, 2003) [14]. Foxtail millet is a good source of protein (12.3 g/100 g), dietary fibre (14 g/100 g), moderate carbohydrate (60.9 g/100 g), rich in minerals (3 g/100 g) and ß carotene (126-191 µg/100 g) (Goudar *et al*., 2011) [12]. Soybean is significantly known not only for its nutrient content but also for its health related benefits and it is usually identified as a 'Miracle golden bean'. On average, dry soybean contains roughly 40% protein, 20% oil, 35% soluble (sucrose, raffinose, stachyose, etc.) and insoluble carbohydrate, dietarys fibre and 5.0% ash (Liu, 2004) [17].

Widespread utilization of the millet and soy still limited mainly because of the non-availability of a variety of food products in the market. The millet semolina does not contain any gluten protein and hence there is a possibility of incorporation of foxtail millet semolina in place of wheat semolina which may be useful for celiac patients. Foxtail millet has not been exploited so far for the preparation for semolina and its utilization in the preparation of instant upma mix.

Materials and Methods

Food commodities

Foxtail millet (*Seteria italica*) procured from Regional Agricultural Research Station, All India Coordinated Research Project on Small Millets, Collage of Agriculture, Rewa. Wheat semolina and soybean (*Glycine max*) were procured from the local market of Adhartal, Jabalpur.

Preparation of foxtail millet semolina

The de-husked foxtail millet was converted into semolina (grits) using a flour mill by adjusting clearance between the rotating discs and the obtained semolina was passed through flour sieve to get flour free semolina of uniform size.

Preparation of soy grits

Soybean grains were thoroughly cleaned to remove the dust and other foreign materials. The cleaned grains were soaked in water for 6-8 hours and autoclaved for 20 minutes to remove the beany flavour and as well as to enhance easy de-hulling. The autoclaved beans were cooled and dried at 60 ºC for about 24 hours. The dried beans were milled to make soy grits and sieved through 80 – 100 mesh sieve to separate soy flour (Ajibola and Filani, 2015) [2].

Development and optimization of instant upma mix

Preliminary studies were performed for the purpose of identifying the appropriate proportions of ingredients, sample combinations, cooking and accordingly percentage of supplementation was established through sensory evaluation. 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 (Balasubramanian *et al.*, 2014) [6] with slight modification. Various acceptability parameters such as, colour & appearance, taste, texture, flavour, after taste and overall acceptability were considered as deciding factors by using the method described by Amerine *et al.* (1965) [3].

Table 1: Different formulations of instant upma mix

Combinations	Foxtail millet semolina	Wheat semolina	Soy grits	Black gram
U1	-	95	-	5
U2	75	20	5	-
U3	65	30	5	-
U4	55	40	5	-
U5	45	50	5	-
U6	95	-	5	-

Preparation of instant upma mix

The foxtail millet semolina and wheat semolina were roasted in non-stick pan on slow flame with constant stirring till (5-7 min) it started to give characteristics aroma and colour of a cooked product. Oil (15 ml) was heated in a pan and mustard seed (0.50 g), fresh green chilies (0.50 g), curry leaves (0.30 g) and soy grits were shallow fried. Roasted semolina (foxtail millet / wheat), salt (3 g) and citric acid (0.20 g) were added in the pan and mixed properly. The samples were cooled, packed in container and stored at ambient condition.

Reconstitution of instant upma mix

Dry mixes (100 g) of foxtail millet semolina based upma were reconstituted with measured amount of hot water (190-200 ml) and stirred on low flame until the desired consistency was attained (started to leave the pan).

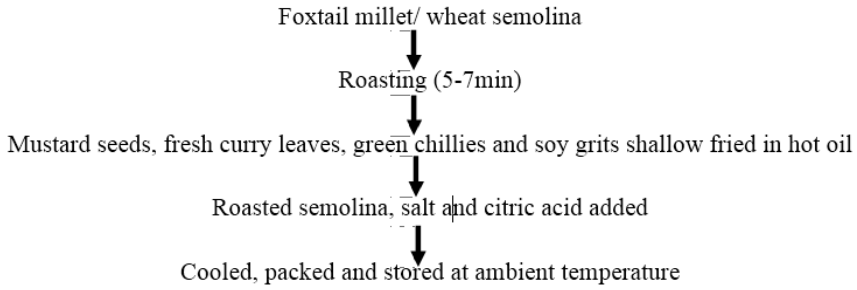

Fig 1: Flow chart of preparation of instant upma mix

Sensory evaluation of upma

The sensory quality characteristics of the upma prepared from various instant mixes were evaluated by panel of 15 trained judges using nine point hedonic scale (1-dislike extremely, 2-dislike very much, 3-dislike moderately, 4-dislike slightly, 5-neither like nor dislike, 6-like slightly, 7-like moderately, 8-like very much and 9-like extremely) as described by Amerine *et al.* (1965) [3]. The samples were identified by code number to the panellists.

Proximate composition of instant upma mix

The moisture content of the sample was determined using moisture meter, protein content by conventional Micro-Kjeldhal digestion and distillation procedure as given in AOAC (1992) [4] using Pelican's Kel Plus digestion and distillation assembly. The fat, ash and crude fibre content of the sample was determined by the procedure as described in AOAC (1992) [4] using Sox plus automatic fat analysis system, Muffle furnace & automatic fibre analysis system (Make- Pelican) respectively. Total carbohydrate was estimated by subtracting the sum of moisture, protein, fat, ash and crude fibre from 100 (Merrill and Watt, 1973) [18]. The total energy value (Kcal) was calculated by using the Atwater factor method [(9 x fat) + (4 x carbohydrate) + (4 x protein)] as described by Nwabueze (2007) [20].

Hunter Colour Measurement

Colour measurement of different instant upma mixes as well as upma prepared from it was done by using a Hunter colour measuring system and expressed in terms of L*, a*, b*, according to the CIE method (1976). L* represents the lightness from white (100) to black (0). Red to green colour component was indicated by a* values and yellow to blue colour components was indicated by the b* values.

Cooking quality

The cooking quality of the instant upma mix was analyzed by the determination of cooking time, water uptake, solids in

cooking water and rehydration ratio as described by Tamilselvi *et al*. (2015) [28].

Cooking time
Cooking time was determined by boiling 2.0g of sample in 20ml distilled water, removing a few sample at different time intervals during cooking and pressing them between two glass plates until no white core was left. Optimum cooking time was taken as the established cooking time plus two (2) additional minutes.

Water uptake
The water uptake ratio was determined by cooking 2.0g of sample in 20ml distilled water for a minimum cooking time in a boiling water bath and drain the superficial water from the cooked sample. The cooked sample was weighted accurately and the water uptake ratio was calculated as the ratio of final cooked weight to uncooked weight of the sample and converted to percentage. Water uptake = (weight of cooked sample / weight of uncooked sample) x 100.

Solids in cooking water
This was determined by drying an aliquot of the cooked water in an evaporated dish to evaporate the water. The weight of the empty petri dish (W1) and weight of petri dish with aliquot (W2) was recorded. The petri dish with aliquot after drying was recorded as (W3). The amount of solid in cooking water was calculated as W3-W1.

Rehydration Ratio
Rehydration ratio (RR), a measure of water absorption by the dehydrated product was calculated using following equation as given by Basantpure *et al.* (2003) [7].

$$R = \frac{W_r}{W_d}$$

Where:
Wr (g) weight of the rehydrated upma mix
Wd (g) weight of the dry upma mix used for rehydration

Statistical analysis
The data obtained from various experiments were statistically analyzed. A complete randomized design was adopted for statistical analysis of data by following the procedure as described by Panse and Sukhatme (1963) [21].

Results and Discussion

Development and optimization of instant upma mix
A number of trials were conducted by taking varying combinations of foxtail millet semolina, wheat semolina and soy grits keeping mustard seeds, fresh chilli, curry leaves/dried spices (chilli) level constant with salt, citric acid, hot oil and water. Accordingly upma mix was prepared with 45-95 percent foxtail millet semolina, 10-50 percent wheat semolina, 5-20 percent soy grits, 10-20 percent oil and 160-200 ml water for cooking. The control upma mix was prepared with wheat semolina (95 g), black gram (5 g), salt (3 g), mustard seeds (0.50 g), fresh chilli (0.50 g), curry leaves (0.50 g), citric acid (0.10 g). In the primary sensory evaluation test, different upma were prepared from different formulations and were evaluated by panelists. The score for the products with 45-95 percent foxtail millet semolina, 20-50 percent wheat semolina, 5 percent soy grits, 15 percent oil were acceptable in terms of all sensory attributes. Panelists suggested the 15 ml oil and 200 ml water/100 gm instant mix for improving the texture and softness of modified instant upma mix as the upma mix with 10 ml oil was too sticky in texture while with 20 ml oil was very oily. Similarly, the pearl millet based upma dry mix was developed and ingredients were optimized by Balasubramanian *et al.* (2014) [6]. They optimized the level of vanaspati to get desirable sensory characteristics after reconstitution. The instant soy-fortified upma mix was also prepared using the optimum level of ingredients by Yadav and Sharma (2008) [30].

Sensory analysis of upma
The upma formulation (U2) prepared from 75%foxtail millet semolina, 20% wheat semolina and 5% soy grits scored highest scores for all the sensory characters viz., colour and appearance (8.42), taste (8.25), flavour (8.63), texture (8.30), after taste (8.50) and overall acceptability (8.42) as compared to other modified combinations. This might be due to addition of fine foxtail millet semolina and soy grits in appropriate combination resulting good colour, nice taste and fine texture of upma. Similarly Itagi *et al*. 2012; [15] Srivastava *et al*. 2014 [27]; Adegunwa *et al*. 2014 reported the acceptable level of foxtail millet flour at 80%, 50% and 100% with regards to readymade foxtail millet mix for diabetics, multigrain semolina blend for upma and composite millet-wheat chinchin respectively whereas Punia *et al.* (2003) [24] prepared acceptable ladoo and shakarpara by substituting maida with 50% kangni flour.

Table 2: Sensory attributes of upma prepared from instant upma mix

Formulations	Colour & appearance	Taste	Flavour	Texture	After taste	Overall acceptability
U1	8.74	8.63	8.80	8.45	8.70	8.66
U2	8.42	8.25	8.63	8.30	8.50	8.42
U3	7.83	7.6	7.56	7.2	8.0	7.63
U4	7.75	7.3	7.40	7.06	7.14	7.33
U5	7.54	7.06	7.20	7.0	7.03	7.16
U6	8.23	8.0	8.45	8.2	8.3	8.23
SEM	0.009	0.058	0.041	0.047	0.044	0.015
CD at 5%	0.028	0.182	0.129	0.150	0.141	0.045

Proximate composition of cooked upma
As can be seen from table 2 that moisture content of upma ranged from 37.50 to 40.60 percent, protein 11.20 to 12.90 percent, fat 6.38 to 8.14 percent, fibre 1.15 to 7.47, ash 2.00 to 3.80 percent, carbohydrate content 30.51 to 38.67 percent and energy value 245.62 to 256.90 Kcal/100 g. The fibre content was increased with increased supplementation of foxtail millet. Similar findings were reported by Poongodi *et al*. (2010) [22] with regard to millet flour blend. Nutritional evaluation of the selected fibre rich food items revealed that the fibre rich product have good nutritional value and found to be a good source of minerals (Bora and Kulshrestha, 2014) [8]. The fat content was increased with increased supplementation of soy grits as well as addition of oil used for the preparation

of instant upma mix. While going through the proximate composition of upma mix the decreased level of carbohydrate as compared to control was noticed as the carbohydrate content of foxtail millet semolina was lower than wheat semolina. Similar results were reported by Singh *et al.* (2005) [26] and Srivastava *et al*. (2014) [27] with regards to composite flours (foxtail, barnyard, finger millet with wheat flour) and multigrain semolina blend respectively. The overall nutritional quality of instant upma mix with substitutions of foxtail millet semolina was higher than control sample. Similar results were reported by Sambavi *et al*. (2015) [25] and Punia *et al.* (2003) [24] whereas Chithra and Sathiya (2008) [9] reported remarkable increase of protein and fibre content in soy incorporated adai, oothapam, pancake, vermicelli upma and vegetable biryani.

Table 3: Proximate composition of cooked upma

Formulations	Moisture (%)	Ash (%)	Crude fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy value (Kcal/100g)
U1	40.60	2.00	1.15	11.20	6.38	38.67	256.90
U2	37.57	3.76	5.94	12.90	7.86	31.97	250.22
U3	38.00	3.54	5.26	12.50	7.77	32.93	251.65
U4	38.52	3.46	4.21	12.45	6.71	34.65	248.79
U5	38.61	3.32	3.54	12.17	6.40	35.96	250.12
U6	37.50	3.80	7.47	12.58	8.14	30.51	245.62
SEM	0.241	0.237	0.009	0.041	0.024	0.009	0.025
CD at 5%	0.761	0.746	0.028	0.130	0.078	0.028	0.079

Hunter colour values of cooked upma

In Hunter colour analysis, the L* value was decreased with increasing level of foxtail millet semolina. Products prepared with foxtail millet semolina, wheat semolina and soy grits showed significant differences in colour values which may be due to incorporation of different type of ingredients in different concentration in the mix. The wide range in lightness values observed for the samples may also be due to the processing conditions such as roasting time and temperature. The reverse trend was observed in a* and b* values of different cooked upma formulations.

Table 4: Hunter colour analysis of cooked upma

Formulations	Hunter colour analysis		
	L*	a*	b*
U1	71.64	1.69	17.96
U2	69.46	2.28	18.95
U3	69.83	3.26	19.39
U4	70.72	2.24	18.91
U5	71.14	3.27	20.37
U6	69.35	1.96	18.01

Cooking quality

The modified samples of instant upma mix needs 7-7.30 minutes and control samples needs 5 minutes for cooking (table 4). Contrast findings was reported by Nazni and Shobana (2016) [19] as foxtail millet grains required 12 minutes to get cooked whereas instant wheat semolina based upma mix could be reconstituted within 4-6 minutes as reported by Premavalli *et al.* (1987) [23]. The cooking time of 15-18 min was reported for noodles developed from composite millet flour by Poongodi *et al*. (2010) [22]. The water uptake of instant upma mixes was found to be highest in U6 formulation prepared from foxtail millet semolina and soy grits whereas lowest in U1 formulation prepared from wheat semolina and black gram dal. Similar findings were reported with regards to noodle prepared from millet incorporated flour by Vijayakumar *et al.* (2010) [29].

The solids in cooking water were higher in the control sample and lower in the modified instant upma mix. The increase in supplementation of foxtail millet decreases the solids in cooking water proved that the percent loss of solids was lower for foxtail millet incorporated upma mix. Similar results reported by Tamilselvi *et al.* (2015) [28] with regards to cooking qualities of minor millets and Vijayakumar *et al.* (2010) [29] for noodle prepared from millet incorporated flour whereas contrast result was reported by Gull *et al.* (2015) [13] with regards to millet supplemented pasta.

Rehydration ratio was higher in the foxtail millet semolina based upma mix as compared to control sample. The increase in RR with increase in amount of water might be due to more water availability as well as more time for reconstitution to get desired consistency. This is in agreement with the findings of Yadav and Sharma (2008) [30] as observed in soy fortified upma. Similar rehydration ratio (2.4 to 3.3) values were reported by Balasubramanian *et al.* (2014) [6] in pearl millet semolina.

Table 5: Cooking quality of instant upma mix

Formulations	Cooking time (min.)	Water uptake (%)	Solids in cooking (%)	Rehydration ratio
U1	5	200	4.00	3.00
U2	7.15	241	3.00	3.50
U3	7	240	3.20	3.40
U4	7	234	4.18	3.20
U5	7	215	4.12	3.16
U6	7.30	242	2.50	4.00

Conclusion

It can be concluded that incorporation of foxtail millet semolina and soy grits improved the quality of instant upma mix in term of nutrient density and sensory attributes. Based on the sensory characteristics, it is clear that 75% foxtail millet semolina, 20% wheat semolina and 5% soy grits was highly acceptable. The fibre, protein, ash and fat content of modified upma were higher as compared to control sample whereas the cooking time was more for improved upma mix. Semolina from foxtail millet could be a new product from

small millets, which can offer inherent health benefits for the people suffering from metabolic disorder.

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