

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.702.112>

Formulation and Quality Evaluation of Modified Upma Mix from Foxtail Millet and Soy for Nutritional Security

Ketki Dhumketi, Alpna Singh* and Priyanka Agrawal

Department of Food Science and Technology, Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur, MP, India

*Corresponding author

ABSTRACT

Upma mix using different combinations of foxtail millet, semolina and soy was developed by modified recipe followed by its sensory, proximate, hunter colour and cooking quality evaluation. The modified upma mix prepared from 65% foxtail millet, 30% semolina and 5% soy was found to be highly acceptable in terms of all sensory attributes. The cooked upma contains moisture content from 37.42 to 40.21%, protein 11.82 to 12.95%, fat 6.30 to 8.12%, ash 2.05 to 3.91%, carbohydrate content 30.39 to 38.44% and provided energy value 244.88 to 257.74Kcal/100 g. The L* value of cooked upma was decreased with increasing level of foxtail millet during hunter colour analysis. The modified upma was found to be taken more cooking time as compared to control sample prepared from wheat semolina and black gram dal. The upma formulation prepared from 95% foxtail millet and 5% soy exhibited higher water uptake and rehydration ratio whereas solids in cooking water was highest in formulation prepared from 55% foxtail millet, 40% semolina and 5% soy. The developed upma can offer inherent health benefits and can also open up better avenues for utilization of millet products for nutritional security.

Keywords

Foxtail millet, Soybean,
Sensory attributes,
Nutritional quality,
Cooking quality, Hunter
colour analysis

Article Info

Accepted:

10 January 2018

Available Online:

10 February 2018

Introduction

Upma is a traditional Indian breakfast dish, cooked as a thick porridge from dry roasted semolina. Various seasonings and vegetables are often added during cooking depending on individual preferences. The indigenous instant food products are prepared at home since ages, but due to the availability of wide range of instant food products in recent years, the consumers are more keen to use the products available in the market using convenient packages at reasonable rate (Unika and Jaffar, 2014).

Millet are unique among the cereals because of their richness in calcium, dietary fibre, polyphenols, carbohydrates (70-80%) and protein (9-14%). It is a gluten-free cereal an excellent source for people suffering from celiac disease and also rich in phytochemicals which help to lower cholesterol level and reduced cancer risk due to its phytate content (Shadang and Jaganathan, 2014). The nutritional qualities of millet have been well recorded (Hulse *et al.*, 1980), its utilization for food is confined to the traditional consumers in tribal populations, mainly due to non-availability of consumer friendly, ready-to-use

or ready-to-eat products as are found for rice and wheat.

Foxtail is minor millet which also called as Italian millets commonly known as kangni, korra, navana, tenai, kakun and rala (Pawar and Pawar, 1997). This millet is a major source of protein, fibre, carbohydrate and other micronutrients in daily diet and thus positively impact on health (thathola, 1999). It is rich source of some essential amino acid mainly leucine, vitamins (thiamin, riboflavin niacin), minerals (calcium, manganese, potassium) and beneficial for diabetic population (Singh *et al.*, 2003). Soybeans protein has been found to reduce the risk of coronary heart disease when consumed as part of a diet low in saturated fat and cholesterol (Tripathi and Misra, 2005).

Foxtail millet has not utilized so far for the preparation of instant upma mix.

Therefore, the present investigation was undertaken to develop modified upma mix by incorporating foxtail millet and soybean and analyze its various quality parameters.

Materials and Methods

Raw materials

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

The foxtail millet was de-husked using millet mill and then 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 separate flour from semolina.

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 to enhance easy de-hulling. The autoclaved beans were cooled and dried at 60°C for about 24 hours. The dried beans were milled to make soy grits and sieved through 80 – 100 mesh sieves to separate soy flour (Ajibola and Filani, 2015).

Development and optimization of instant upma mix

Preliminary studies were performed to identify the appropriate combinations of ingredients, appropriate cooking time and accordingly percentage of supplementation was established through sensory evaluation. Several formulations of raw materials 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 (Dhumketi *et al.*, 2017) with slight modification. Various acceptability parameters such as colour and appearance, taste, texture, flavour, after taste and overall acceptability were considered as deciding factors by using the method described by Amerine *et al.*, (1965).

Modified upma mixes prepared by substituting foxtail millet by replacing wheat semolina and black gram by soy in different proportion of foxtail millet, wheat semolina and soy (UM2-75:20:5, UM3-65:30:5, UM4-55:40:5, UM5-45:50:5, UM6-95:0:5) respectively. The control sample was prepared by using 95% semolina and 5% black gram dal (UM1).

Preparation of modified upma mix

The foxtail millet semolina, soy grits and wheat semolina were roasted separately in non-stick pan on slow flame with constant

stirring till it started to give characteristic aroma and colour. 10 ml oil was heated in a pan and mustard seeds (0.50 g) were fried, and roasted ingredients were added in a pan and mixed properly. Salt (3 g), citric acid (0.10 g), tartaric acid (0.10 g), dried green chilies (0.50 g), curry leaves (0.30 g), ginger (2 g), coriander leaves (0.20 g) were also added to the pan. The samples were cooled, packed in container and stored at ambient condition.

Reconstitution of modified upma mix

100 g dry mixes of modified upma was reconstituted with measured amount of hot water (200 ml) and stirred on low flame until the desired consistency was attained (started to leave the pan).

Sensory evaluation of upma

The sensory quality characteristics of the upma prepared from various upma 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).

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) 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) 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). The total energy value (Kcal) was calculated by using the Atwater factor method $[(9 \times \text{fat}) + (4 \times \text{carbohydrate}) + (4 \times \text{protein})]$ as described by Nwabueze (2007).

Hunter colour measurement

Colour measurement of different cooked upma 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 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).

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.

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).

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

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).

Results and Discussion

Development and optimization of modified upma mix

Various trials were conducted by using varying formulations of foxtail millet,

semolina and soy keeping mustard seeds, dried spices (chilli, ginger, coriander and curry leaves) level constant with salt, citric acid, tartaric acid, hot oil and water. Accordingly upma mix was prepared with 45-95 percent foxtail millet, 10-50 percent semolina, 5-20 percent soy, 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), dried chilli (0.50 g), curry leaves (0.50 g), ginger (2 g), coriander leaves (0.20 g), citric acid (0.10 g), tartaric 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, 20-50 percent semolina, 5 percent soy, 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) (Fig. 1).

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). Similarly Dharmaraj *et al.*, (2016) prepared semolina from foxtail millet and evaluated its nutritional, physical and functional properties and Chithra and Sathiya (2008) developed soy incorporated adai, oothapam, pancake, vermicelli upma, vegetable biryani where soy was incorporated in different forms as per the suitability of the recipe. Deshpande and Posadri (2011) utilized the foxtail millet (*Setaria italica*) along with other flour for production of ready-to-eat snack products.

Table.1 Sensory attributes of upma

Formulations	Colour & appearance	Taste	Flavour	Texture	After taste	Overall acceptability
UM1	8.82	8.70	8.50	8.65	8.53	8.64
UM2	8.34	8.27	8.0	8.20	8.05	8.17
UM3	8.55	8.40	8.40	8.50	8.30	8.43
UM4	7.80	7.53	7.20	7.52	7.80	7.57
UM5	7.50	7.30	7.00	7.24	7.20	7.24
UM6	8.45	8.35	8.32	8.40	8.16	8.33
SEM	0.037	0.045	0.057	0.037	0.045	0.016
CD at 5%	0.116	0.142	0.181	0.118	0.143	0.049

Table.2 Proximate composition of cooked upma

Formulations	Moisture (%)	Ash (%)	Crude fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy value (Kcal/100g)
UM1	40.21	2.05	1.18	11.82	6.30	38.44	257.74
UM2	37.46	3.79	5.96	12.95	7.94	31.94	251.02
UM3	38.14	3.55	5.35	12.47	7.76	32.73	250.64
UM4	38.38	3.41	4.30	12.42	6.75	34.74	249.12
UM5	38.45	3.28	3.68	12.15	6.37	36.07	250.21
UM6	37.42	3.91	7.60	12.56	8.12	30.39	244.88
SEM	0.008	0.096	0.034	0.009	0.013	0.014	0.014
CD@5%	0.025	0.303	0.108	0.027	0.043	0.042	0.044

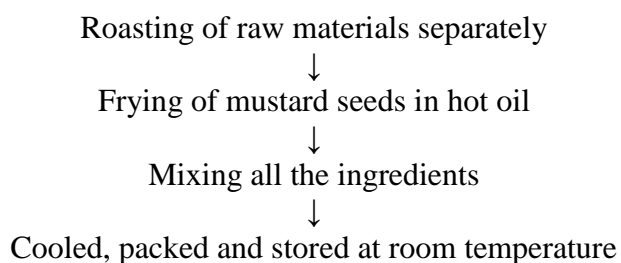
Table.3 Hunter colour value of cooked upma

Formulations	Hunter colour analysis		
	L*	a*	b*
UM1	64.01	2.25	16.91
UM2	59.79	2.08	18.35
UM3	62.39	2.91	17.48
UM4	62.45	3.66	19.97
UM5	63.52	3.31	18.79
UM6	55.53	3.76	19.09

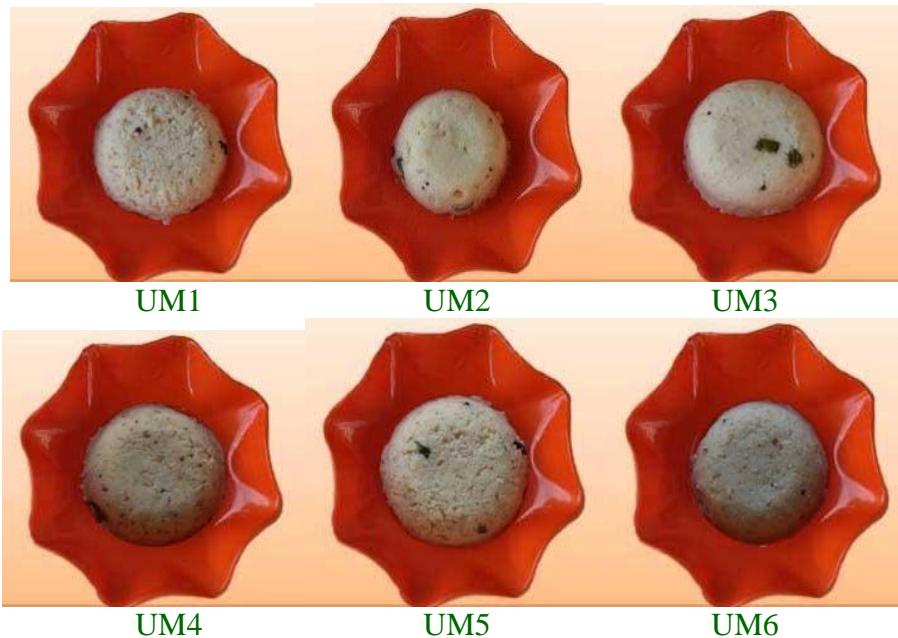
Table.4 Cooking quality of modified upma mix

Formulations	Cooking time (min.)	Water uptake (%)	Solids in cooking (%)	Rehydration ratio
UM1	5	196	4.05	2.80
UM2	7.10	210	3.12	3.40
UM3	7	230	3.10	3.35
UM4	7	235	4.15	3.20
UM5	7	225	4.10	3.08
UM6	7.30	240	3.00	3.50

Fig.1 Flow chart of preparation of modified upma mix



Different formulations of upma mix



Sensory analysis of upma

The scores for sensory parameters of upma formulation (UM3) prepared from 65%

foxtail millet, 30% semolina and 5% soy was highest in terms of colour and appearance (8.55), taste (8.40), flavour (8.40), texture (8.50), after taste (8.30) and overall

acceptability (8.43) table 1. 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. The supplementation of foxtail millet in formulations with higher percentage resulted good acceptability of upma. The present findings are in contrast with the results reported by Poongodi *et al.*, (2010) with regards to noodle prepared from composite flour (millet, wheat and soy). Whereas Punia *et al.*, (2003) prepared acceptable ladoo and shankarpara by substituting maida with 50% kangni flour. Similarly Itagi *et al.*, 2012; Srivastava *et al.*, 2014; Adegunwa *et al.*, 2014 reported the acceptable level of foxtail millet flour at 80%, 50% and 100% respectively.

Proximate composition of cooked upma

Data depicted in table 2 shows the proximate composition of foxtail millet based cooked upma. The moisture content of upma ranged from 37.42 to 40.21%, protein 11.82 to 12.95%, fat 6.30 to 8.12 %, crude fibre 1.18 to 7.60 %, ash 2.05 to 3.91%, carbohydrate 30.39 to 38.44 % and energy value was found to be 244.72 to 257.74Kcal/100 g. 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) and Punia *et al.*, (2003) with regards to development of cookies using a combination of foxtail millet and wheat flour and nutritional evaluation of kangni (*Setaria italic*) respectively. The fibre content was increased with increased supplementation of foxtail millet. Similar findings were reported by Poongodi *et al.*, (2010) with regard to millet flour blend.

Hunter colour values of cooked upma

As can be seen from the table 3, the L* value was decreased with supplementation of foxtail

millet semolina as compared to control. Products prepared with foxtail millet, semolina and soy 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.

Cooking quality

Cooking characteristics of upma mix are given in table 4. The cooking time ranged from 5-7.30 minutes for modified upma mix. The modified sample (UM6) needs maximum time (7.30 min.) for cooking while control sample needs 5 min. Contrast result reported by Poongodi *et al.*, (2010) for noodles developed from composite millet flour. The time taken for cooking of upma increased with increase in the level of incorporation of millet. Similar result reported by Thilagavathi *et al.*, (2015) with regards to standardization of extruded products using modified millet flour and pulse flour.

The water uptake of modified upma mixes was found to be highest in the formulation UM6 supplemented with foxtail millet and soy grits whereas lowest in UM1 prepared from wheat semolina and black gram dal. Similar result was also obtained in noodle prepared from millet incorporated flour by Vijayakumar *et al.*, (2010) whereas contrast result was reported by Gull *et al.*, (2015) with regards to millet supplemented pasta.

The solids in cooking water were higher in control sample and lower in foxtail millet based modified upma mix. The increase in supplementation of foxtail millet decreases the solid in cooking water that proved the percent loss of solids was minimum for

foxtail millet. Similar result was also obtained in noodle prepared from millet incorporated flour by Vijayakumar *et al.*, (2010) whereas contrast result was reported by Gull *et al.*, (2015) with regards to millet supplemented pasta.

The rehydration ratio with different combinations of upma mix was found to be highest in modified upma mix and lowest in control sample. Similar result was reported by Balasubramanian *et al.*, (2014) as they reported that the rehydration ratio was found to be from 2.4 to 3.3 in pearl millet semolina.

It can be concluded that replacement of wheat semolina by foxtail millet and soy exhibited excellent nutritional quality along with good sensory profile. Foxtail millet and soy can be used successfully for the preparation of ready to cook food products. The developed upma can offer inherent health benefits and can also open up better avenues for utilization of millet products for nutritional security.

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How to cite this article:

Ketki Dhumketi, Alpana Singh and Priyanka Agrawal. 2018. Formulation and Quality Evaluation of Modified Upma Mix from Foxtail Millet and Soy for Nutritional Security. *Int.J.Curr.Microbiol.App.Sci*. 7(02): 888-896. doi: <https://doi.org/10.20546/ijcmas.2018.702.112>