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Ketki Dhumketi
Krishi Vigyan Kendra, JNKVV, Jabalpur, Madhya Pradesh, India

Pooja Chaturvedi
Krishi Vigyan Kendra, JNKVV, Jabalpur, Madhya Pradesh, India

Ajay Kumar Shah
State Forest Research Institute, Jabalpur, Madhya Pradesh, India

Alpana Singh
Department of Food Science and Technology, JNKVV, Jabalpur, Madhya Pradesh, India

Anamika Patel
Department of Food Science and Technology, JNKVV, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Ajay Kumar Shah
State Forest Research Institute, Jabalpur, Madhya Pradesh, India

Studies on physico-chemical, functional and shelf life characteristics of foxtail millet based upma mix

Ketki Dhumketi, Pooja Chaturvedi, Ajay Kumar Shah, Alpana Singh and Anamika Patel

Abstract
The purpose of this work is to investigate the nutritional composition of millet-based instant mix prepared from a mixture of foxtail millet semolina, wheat semolina and soybean. Millets are a rich source of vitamins, minerals, non-starch polysaccharides and sulphur-containing amino acids. Millets are also called a nutritional grain. The prepared mixes was analysed for its proximate composition such as moisture, protein, fat, fibre, ash, carbohydrate and energy value content varied from 7.25 to 8.42%, 11.00 to 13.50%, 7.20 to 8.60%, 1.20 to 7.62%, 2.02 to 3.86%, 59.87 to 70.16% and 368.08 to 389.44 kcal/100 g respectively. The mineral***s*** content of instant upma mixes prepared from millets were higher than wheat semolina. Physical attribute such as WAC (water absorption capacity) was higher and FAC (Fate absorption capacity) was lower than instant upma mix prepared from wheat semolina. The instant upma mixes was stored up to 2 months at ambient condition in aluminium foil packaging.

Keywords: Foxtail millet, semolina, instant, upma, soybean

Introduction
Instant foods are prepared from almost all available food grains, either alone or supplemented with fruits, vegetables, legumes, oilseeds, flavouring agents, colouring agents, preservatives etc. (Pathania *et al*. 2013) [20]. These food products are the most convenient foods because they only need to be reconstituted in boiling water and simmered for 2 to 10 minutes, depending on the processing method and the food's content. (Patel *et al*., 2022) [19]. Consumers are keener to use the products available in the market using convenient packages at reasonable rate.
Millets are traditional food for poor farmers in various regions, especially in the arid regions of our country. Millets are also known as nutri- cereals. Nowadays, the demand for millets and its products are increasing due to processing technologies to produce value-added products. Millets have high nutritional value compared to wheat and rice (Mishra *et al*. 2021) [14]. Governmental and non-governmental organizations that educate people about the use of millet through awareness and nutrition activities also helping toward develop new markets for millet as well as promote research and development of millet production. Foxtail millet contain protein 12.3 gm, dietary fibre 4 gm, carbohydrate 60.9 gm and minerals 3 gm. Goudar *et al*., (2011) [11]. Due to nutritional properties of foxtail millet has been proven to have several health benefits, such as: Cancer prevention and hypoglycaemic and hypolipidemic effects (Sharma and Niranjan 2017) [23]. Soybean protein is one of the least expensive sources of dietary protein (Derbyshire *et al.,* 1976) it's considered to be a good substituent for animal protein (Sacks *et al.,* 2006) [22] and there nutritional profile is almost similar to animal proteins, except for the sulfur-containing amino acids (methionine and cysteine), since soy proteins contain most of the essential amino acids necessary for the nutrition of animals and humans. Instant mixes and ready meals, often in dry form, must be mixed with water before consumption. The main objective of this study was to develop a millet based instant upma for analyzed its various quality parameters.

Material and Methods
The instant upma mix raw materials selected for the study were foxtail millet (*Setaria italica*), soybean (*Glycine max*) and black gram. Foxtail millet procured from RARS, AICRP, Small Millets Rewa and Other material purchased from local market.

Table 1: Composition of row material used in formulation of Instant Upma Mix

S. No	Materials	Amount
1	Foxtail millet	45-95 gm
2	Wheat semolina	20-95 gm
3	Black gram	5 gm
4	Soy grits	5 gm
5	Oil	15 ml
6	Green chilies	0.50 gm
7	Curry leaves	0.30
8	Salt	3 gm
9	Citric acid	0.20 gm
10	Mustard seed	0.50 gm

Formulation and preparation

The instant upma mix was prepared from foxtail millet semolina and wheat semolina roasted in non-stick pan on slow flame. Oil was heated in a pan add mustard seed, curry leaves, shallow fried to fresh green chillies and soy grits. All roasted semolina (foxtail millet and wheat) incorporate with some salt and citric acid followed by mixed properly with fried ingredients in pan. The samples were cooled then packed in different packaging material for stored 60 days at ambient.

Table 2: Different formulations of instant upma mixes

S. No.	Treatment	Formulation Techniques
1	U1	g Wheat Semolina + Black gram
2	U2	75 g Foxtail millet + 20 g Wheat Semolina + 5 g Soy Grits
3	U3	65 g Foxtail millet + 30 g Wheat Semolina + 5 g Soy Grits
4	U4	55 g Foxtail millet + 40 g Wheat Semolina + 5 g Soy Grits
5	U5	45 g Foxtail millet + 50 g Wheat Semolina + 5 g Soy Grits
6	U6	95 g Foxtail millet + 5 g Soy Grits

Physical attributes

Colour measurement of instant upma mixes was done by using a Hunter colour measuring system and expressed in terms of L*, a*, b*, according to the CIE method (1976). The bulk density was calculated and expressed in g ml^{-1} as per method by Jones *et al.* (2000) [12].

Proximate composition

The sample of upma mix analyzed for the moisture contents, protein, fat, ash and crude fibre by the methods of AOAC (2007) [3]. Total carbohydrate was estimated through the formula of Merrill and Watt (1973) [13]. The total energy value in Kcal was calculated using the Atwater factor method [(9 x fat) + (4 x carbohydrate) + (4 x protein)] as described by Nwabueze (2007) [17]. Mineral contents of mixes were calculated by using table values (Gopalan *et al.*, 1996) [10].

Functional Characteristics

FAC and WAC were measured by the method of Sosulski *et al.*, (1976) [24] and Sosulski *et al.*, (1962) [25] respectively.

Statistical Analysis

The data obtained were statistically analysis through using a complete randomized design (CRD) explained by Panse and Sukhatme (1963) [18].

Storage studies

The storage stability of instant upma mix was carried out by using low density polyethylene (LDPE), polypropylene (PP) and aluminium foil pouches for the 2 month period at ambient conditions. Selected sample were drawn periodically after 0, 30, 60 days and overall acceptability analyzed, moisture, free fatty acid and peroxide value by the method of AOAC (2007) [3], Ranganna (1986) [21] and Amerine *et al*., (1965) [2].

Results and Discussions

Development and Standardization

Development of mixes by taking varying quantity of foxtail millet semolina, wheat semolina, soy grits and constant level of mustard seeds, fresh chilli, and curry leaves, salt, citric acid, oil and water. The instant upma mix was prepared using earlier mentioned basic recipe by Balasubramanian *et al*., (2014) [4] was developed pearl millet based upma dry mix. Nayi and Kumar (2021) [16] used RSM for optimization of levels and ingredients for the development of ready-to reconstitute sweet corn halwa. Divakar *et al.*, (2021) [9] prepared foxtail millet based composite flour**.**

Proximate analysis of instant upma mix

The above Table 3 indicated, the moisture was to be varies from 7.25 to 8.42%, protein 11.00 to 13.50%, fat 7.20 to 8.60%, fibre 1.20 to 7.62%, ash 2.02 to 3.86%, carbohydrate 59.87 to 70.16% and energy value content 368.08 to 389.44 kcal/100 g. That is observed that in upma mix, increased the level of foxtail millet semolina resulted the gradual increase in protein, ash, fat, and crude fibre and decreased the content of carbohydrate. The fibre and fat content was highest in foxtail millet based mixes as compared to control sample, similar result observed by Divakar *et al*., (2021) [9] with regard to millet flour blend.

Table 3: Proximate analysis of instant upma mix

Formulations	Moisture (%)	Ash (%)	Crude fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy value (Kcal/100 g)
U1	8.42	2.02	1.20	11.00	7.20	70.16	389.44
U2	7.62	3.80	6.10	13.50	8.45	60.53	372.17
U3	7.76	3.65	5.30	12.78	8.21	62.30	374.21
U4	7.90	3.54	4.50	12.70	7.66	63.70	374.54
U5	8.20	3.46	3.82	12.40	7.31	64.81	374.63
U6	7.25	3.86	7.62	12.80	8.60	59.87	368.08
SEM	0.034	0.025	0.039	0.240	0.033	0.015	0.01
CD (5%)	0.107	0.079	0.123	0.758	0.106	0.047	0.052

Mineral composition in Instant Upma Mix

The mineral content such as iron, calcium and phosphorus showed in Table 4. The concentration of iron ranged from 1.90 to 2.94 mg/100 g, calcium from 27.00 to 40.91 mg/100 g and phosphorus 130.97 to 297 mg/100 g were high, due to the presence of foxtail millet and soy in the mixture. This is in

close agreement with a previous study by Divakar *et al*., (2021) [9] Also, in a review done on foxtail millet indicated it was rich in minerals such as phosphorus in comparison to other minor millets Muthamilarasan and Prasad (2015) [15].

Table 4: Mineral composition of instant upma mix (mg/100 g)

Formulations	Calcium	Phosphorus	Iron
U1	27.00	130.97	1.90
U2	37.47	270.85	2.85
U3	36.01	251.3	2.70
U4	35.30	232.6	2.50
U5	34.20	251	2.42
U6	40.91	297	2.94

Physical attributes of instant upma mix

The result of Table 5 showed the physical characteristics of instant upma mix. The bulk density of instant upma mixes observed that from 0.73 to 0.78 g/ml. Bulk density of instant upma mix was more than to control sample. The highest value of lightness was 68.72 of U1 (Control) and lowest value 65.23 of U6 (foxtail millet semolina). The highest value of a* and b* (4.97 and 27.11) reported from U3 (65% foxtail millet semolina, 30% wheat semolina and 5% soy grits). Hence it can be concluded that increasing the level of foxtail millet semolina resulted the L* value was decreased and reverse trend was observed in a* and b* values of different formulations. Similar result reported by Dhumketi *et al.*, 2018 [8] in instant upma mix prepared by using from foxtail millet semolina and soy grits.

Table 5: Physical attributes of instant upma mix

Formulations	Hunter Colour Analysis			Bulk Density (g/ml)
	L*	a*	b*	
U1	68.72	3.15	24.69	0.73
U2	66.13	4.20	26.24	0.77
U3	67.65	4.97	27.11	0.76
U4	67.68	4.54	26.51	0.74
U5	67.88	4.44	26.42	0.75
U6	65.23	3.07	24.91	0.78

Functional attributes of Instant upma mix

The Table 6 reflected that highest value of WAC and FAC observed in U6 (248 ml/100 g) and U1 (230 ml/100 g) whereas lowest in U5 (214 ml/100 g) and U6 (198 ml/100 g) respectively. Higher water absorption and lower fat absorption capacity by the millet flour compared to refined wheat flour showed the high WAC and FAC of millets as reported by Abedin *et al.*, (2022) [1]. Previously, Chandra (2013) [5] studied about water and oil absorption capacities of flour are influenced by surface polarity, amino acid composition, and protein conformation.

Table 6: Functional attributes of instant upma mix

Formulations	Water absorption capacity (ml/100 g)	Fat absorption capacity (ml/100 g)
U1	220	230
U2	218	215
U3	216	216
U4	215	218
U5	214	220
U6	248	198

Shelf life of instant upma mix

The selected samples control (U1) and best formulation in sensory analysis (U2) were finalized for shelf life study using different packaging material (Polypropylene, Low density polyethylene and aluminium foil) after 0, 30 and 60 days and Results indicated that in Table 7.

The moisture content in upma mix (U1) was slightly increases in from 8.42% to 9.10% (P1U1), 9.0% (P2U1) and 9.15% (P3U1) respectively. Also another sample of upma mix (U2) initially it was 7.62% that is increased upto 7.70% (P1U2), 7.69% (P2U2) and 7.72% (P3U2) respectively.

The Initial value of free fatty acid in upma mix (U1) was observed in control sample was 0.24% that increased 0.29% (P1U1), 0.28% (P2U1) and 0.30% (P3U1) whereas in sample of upma mix (U2) the initial value was 0.28% that increased upto 0.34% (P1U2), 0.32% (P2U2) and 0.35% (P3U2) oleic acid at the end of storage it was reflected in Table 7.

Peroxide value was varied upma mix (U1) in 3.6 to 10.10 meq/kg in P1U1, 3.6 to 9.60 meq/kg in P2U1 and 3.6 to 10.12 meq/kg in P3U2. While in another sample of instant upma mix (U2) showed that 3.3 to 11.10 meq/kg in P1U2, 3.3 to 10.50 meq/kg in P2U2 and 3.3 to 11.15meq/kg in P3U2.

Overall acceptability of upma mix (U1) was slightly decreased from 8.80 to 8.71 in P2U1, 8.75 in P2U1 and 8.70 in P3U1 and another sample of upma mix (U2) was 8.62 to 8.50 for P1U2, 8.52 of P2U2 and 8.48 of P3U2. The selection of packaging materials for storage are thus justified as aluminium foil had better result as compared to low density polyethylene and polypropylene in favour of moisture content, free fatty acid, peroxide value and overall acceptability of the product. The contrast result was finding by Yadav and Singh (2016) [26] in full fat soy flour based instant mangodi mix was stored in polypropylene.

Table 7: Shelf life of instant upma mix

Parameters	Formulations	0 days	30 days	60 days
Moisture %	P1U1	8.42	8.75	9.10
	P2UI	8.42	8.70	9.00
	P3U1	8.42	8.80	9.15
	P1U2	7.62	7.65	7.70
	P2U2	7.62	7.63	7.69
	P3U2	7.62	7.66	7.72
Free fatty acid (%Oleic Acid)	P1U1	0.24	0.27	0.29
	P2UI	0.24	0.26	0.28
	P3U1	0.24	0.28	0.30
	P1U2	0.28	0.32	0.34
	P2U2	0.28	0.30	0.32
	P3U2	0.28	0.30	0.35
PV (meq. of O2/kg Fat)	P1U1	3.6	7.2	10.10
	P2UI	3.6	5.5	9.60
	P3U1	3.6	5.8	10.12
	P1U2	3.3	7.5	11.10
	P2U2	3.3	6.4	10.50
	P3U2	3.3	8	11.15
Overall acceptability	P1U1	8.80	8.75	8.71
	P2UI	8.80	8.78	8.75
	P3U1	8.80	8.72	8.70
	P1U2	8.62	8.57	8.50
	P2U2	8.62	8.55	8.52
	P3U2	8.62	8.47	8.48

P1- Low Density Polyethylene, P2-Aluminium Foil, P3-Polypropylene

U1- Control**,** U2- Best formulation in sensory analysis

Conclusion

This study investigated the potential use of foxtail millet grains in food formulations, particularly as a functional ingredient that may contribute to the development of health status and consumption behaviour. It can be concluded that foxtail millet based upma mixes had higher nutritional supplementation and significantly improved in iron, calcium, fibre, protein, ash and calcium contents than the control samples (wheat semolina + black gram). Therefore, the development and uses of foxtail millet semolina will improve the nutritional status of the consumer. Instant upma mixes can be stored in aluminium foil containers at ambient conditions for up to two months for easy and safe consumption.

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