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Standardization and Evaluation of Small Millet based Instant Adai Mix

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In the present investigation attempts have been made to develop nutrient rich instant adai mix by the addition standardized proportion of kodo millet and barnyard millet with other ingredients (blackgram dhal, whole green gram, bengal gram, redgram dhal and horsegram). They were made from different ratio *viz*., kodo millet flour, blackgram dhal, whole green gram, bengal gram, redgram dhal, horsegram, chilli powder and asafoetida (100:10:10:10:10:10:4:1) and barnyard millet flour, blackgram dhal, whole green gram, bengal gram, red gram dhal, horsegram, chilli powder and asafoetida (100:10:10:15:10:10:4:1). The proximate composition of millet blends instant adai mix contained higher protein, fibre and minerals such as calcium, phosphorus and iron. Sensory attributes of instant adai mixes were highly acceptable. It can be stored in Metallised Polypropylene with antioxidant for the period of 180 days. The cost of small millet based instant adai mix was worked out to be Rs.8.23 (T_1) and Rs.7.78 (T_2) respectively.

Key words: Nutrients, Small millet, Proximate Composition, Protein

India is the leading producer of small millets namely, finger millet (*ragi*), kodo millet (*kodo*), foxtail millet (*kangni*), barnyard millet (*sawan*), proso millet (*cheema*) and little millet (*kutki*) (Majumdar *et al.,* 2006). Annual planting area around 2.5 million hectares and nearly 1.5 million hectares is under small millet like finger millet and kodo millet comprising about 40-50 per cent of crop's global area. During the last three decades, area under kodo millet and barnyard millet has declined, but with the significant improvement in the productivity (1,500 kg/ha), its annual production was maintained at around 2.4 million tonnes. The small millet grains have longer storage life, and can be termed as famine reserve. The resilience exhibited by them may prove good for their adjustment to different eco-systems and make them potential crops for contingency plantings. Cereals form a major portion of human diet and are an important source of starch and other dietary carbohydrates (dietary fibre), which play an important role in the energy requirement and nutrient intake of human. The millets are with higher fibre content, and their protein quality and mineral composition contribute significantly to nutritional security of a large section of population (Desai *et al.,* 2010). Millets are most recognized nutritionally for being a good source of minerals magnesium, manganese and phosphorus. Research has linked magnesium to a reduced risk for heart attack and phosphorus is important for the development of body tissue and energy metabolism. Millets are also rich in phytochemicals, including phytic acid (Shashi *et al.,* 2007), which is believed to lower cholesterol, and phytate, which is associated with reduced cancer risk.

Most of the foods consumed by people in India are traditionally processed. (Desikachar,1998). However their preparation is time consuming and laborious with result that convenience foods based on traditional processing has entered the market with huge success. Processing of small millets based instant food mixes would be successful strategy to promote millet utilization. Hence, the present investigation was undertaken to standardized nutritious instant adai mix from kodo millet and barnyard millet with pulses combination.

Materials and Methods

Kodo millet rice and barnyard millet rice were procured from the millet growing area of Peraiyur block at Madurai district, Tamilnadu. Legumes such as whole green gram, bengal gram dhal, black gram dhal, horsegram and red gram dhal were procured from local market in Madurai. All the chemicals and glassware's used in the present investigation were standard companies (Merck and Borosil).

Preparation of millet flour

Kodo millet rice and barnyard millet rice were cleaned to remove dirt, dust and stone. The cleaned materials were ground separately by using pulveriser and sieved by 60 mesh sieves. The flour samples obtained were kept in airtight container before use.

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Preparation of legumes flour

Legumes such as whole green gram, bengal gram dhal, black gram dhal, horsegram and red gram dhal were cleaned to remove the foreign materials and then ground separately in electric grinder to make fine powder and sieved by 60 mesh sieve. The obtained flour was stored in airtight container before use.

Preparation of instant adai mix

Two types of adai mixes were standardized. One based on kodo millet flour and second on barnyard flour. Preliminary studies indicated that 100 per cent incorporation of kodo millet/ barnyard millet flour for the preparation of instant adai mix was highly suitable. The ingredient used in the preparation of kodo millet instant adai mix were kodo millet flour, blackgram dhal, whole green gram, bengal gram, redgram dhal, horsegram, chilli powder and asafoetida in the proportion of 100:10:10:15: 10:10:4:1g and the barnyard millet instant adai mix was prepared from barnyard millet flour, blackgram dhal, whole green gram, bengal gram, red gram dhal, horse gram, chilli powder and asafoetida in the proportion of 100:10:10:15:10:10:4:1 g. The flow chart for the preparation of small millet based instant adai mix is given in Fig.1.

Kodo/ Barnyard millet :whole greengram: bengal gram dhal: black gram dhal: horsegram: red gram dhal

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Cleaning (to remove dust and stone)

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Washing and soaking (2 hours)

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Drying

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Grinding (by using pulverizer)

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Sieving (60 mm sieve)

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Adding red chilli powder (4%), asafoetida (1 %) and salt (2%)

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Adai Mix

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Packing

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Storing at ambient temperature

Fig.1. Flow chart for the preparation of adai mix

Quality evaluation of the small millet based instant adai mix

Physico - chemical analysis of adai mix

The physiochemical analysis of the adai mix i.e. moisture content, starch, protein, crude fibre, tannin, minerals *viz*., calcium and iron were determined by AOAC (2007).

Sensory evaluation of adai mix

The sensory evaluation of adai mix was made by panel of 15 semi trained judges as described by Amerine *et al.,* (1965) on 9 point hedonic scale during initial and final period of storage.

Microbial load of small millet adai mix during storage

The microbial load of the stored samples were enumerated once in 30 days by the method described by Istavankiss (1984).

Storage studies

The shelf life studies of adai mix were carried out in different packaging materials *viz*., High Density Poly Ethylene (HDPE- P_1), Aluminium foil (P_2) and Metallised polyester polyethylene laminate pouches (MPP- P_3) for a period of 180 days at ambient temperature. All mixes were drawn periodically after 0,30,60,90,120,150,180 days and further, physio chemical, sensory and microbial were carried out. Statistical analysis (Factorial Completed Randomised Design (FCRD) as per procedure given in the references.

Cost analysis

The cost involved in the processing of small millet based instant adai mix was computed by taking into account the fixed and variable cost involved during the course of processing.

Results and Discussion

Proximate composition of adai mix

From Table 1 it can be seen that moisture content varied from 11.35 to 11.00 g per cent with the lowest T_1(11.00 g /100g) and highest is T_2(11.35 g /100g). The starch content of adai mixes ranged from 27.68 to 31.46 g per 100 g. The highest starch content was recorded in T_1 and lowest in T_2. The protein content varied from 14.00 to 15.70 g percent with the lowest in T_2(14.00 g /100 g) and highest in T_1 (15.70 g/100 g). The high amount of crude fibre was in T_2(7.78 g/100g) and lowest in T_1(6.20 g/100g). The maximum amount of tannin were recorded in T_2 (6.25 mg /100 g) and lowest in T_1(5.70 mg/ 100 g). The calcium content ranged from 60.20 to 71.30 mg per 100 g in adai mixes. The phosphorus content was highest in barnyard millet (336.28 mg/100 g) adai mix when compared to kodo millet adai mix. The iron content was recorded high in T_2 adai mix followed by T_1.

Chemical constituents of the small millet based instant adai mix during storage (Table 2)

Moisture

A gradual increasing trend in moisture content was noted kodo and barnyard millet adai mix during the storage period. Initially moisture content of kodo(T_1) and barnyard millet (T_2) adai mix was found to be 11.0 and 11.35 g per cent. The moisture content of the mixes increased gradually depending upon on the different packaging materials. Among the packaging the samples packed in High Density Polyethylene (P_1) recorded high moisture content than $P_2$and P_3 after180 days of storage.The moisture content of the mixes showed highly significant differences at 0.05 per cent level storage. This moisture pick up might be due to the difference in the barrier capacity of the packaging materials. Parvathi (2010) recorded a moisture content of 11.35 g per 100 g in multigrain adai mix which is similar to the moisture content of the adai mix in the present study.

Starch

A decreasing trend in the starch content during storage was observed. The kodo millet adai mix had higher starch content (31.46 g /100 g) than barnyard millet adai mix (27.68 g/100 g) initially. At the end of the storage period the starch content of kodo millet and barnyard millet adai mix were 31.04 g per 100 g for HDPE, 31.10 g per 100 g for aluminium foil and 31.12 g per 100 g for MPP and 27.25 g per 100 g for HDPE, 27.30 g per 100 g for aluminium foil and 27.32 g per 100 g for MPP respectively. Among the packaging materials higher per cent retention of starch content was observed in the samples packed in MPP than HDPE. The starch content of the mix showed highly significant difference at 0.05 per cent on storage. These results were in tune with the studied of Bhavani (2000) who had also reported a significant reduction in the starch content of the instant adai mix packed in polypropylene bag during storage at room temperature.

Table 1. Proximate composition of adai mix

Products	Moisture (g)	Starch (g)	Protein (g)	Crude fibre (g)	Tannin (mg)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Kodo millet adai mix (T_1)	11.00	31.46	15.70	6.20	5.70	71.30	244.70	5.88
Barnyard millet adai mix (T_2)	11.35	27.68	14.00	7.78	6.25	60.20	336.28	7.30

Table 2. Nutrient changes of adai mix during storage

Nutrients	Storage period	Kodo millet (T_1)			Barnyard millet (T_2)			CD at 0.05 %
		P_1	P_2	P_3	P_1	P_2	P_3	
Moisture (g)	Initial	11.00	11.00	11.00	11.35	11.35	11.35	0.02636**
	Final	11.60	11.52	11.48	11.87	11.81	11.78	
Starch (g)	Initial	31.46	31.46	31.46	27.68	27.68	27.68	0.02792**
	Final	31.04	31.10	31.12	27.25	27.30	27.32	
Protein (g)	Initial	15.70	15.70	15.70	14.00	14.00	14.00	0.02731**
	Final	15.52	15.54	15.56	13.82	13.85	13.88	
Crude fibre (g)	Initial	6.20	6.10	6.10	7.78	7.78	7.78	0.0242 NS
	Final	6.10	6.14	6.16	7.69	7.72	7.74	
Tannin (mg)	Initial	5.70	5.70	5.70	6.25	6.25	6.25	0.03364NS
	Final	5.45	5.52	5.62	6.11	6.15	6.18	
Calcium (mg)	Initial	71.30	71.30	71.30	60.20	60.20	60.20	0.01373NS
	Final	71.22	71.25	71.27	60.04	60.10	60.12	
Iron (mg)	Initial	5.88	5.88	5.88	7.30	7.30	7.30	0.02726NS
	Final	5.77	5.80	5.83	7.21	7.23	7.25	

P_1- HDPE, P2-Aluminium foil, P3- MPP, ** High Significant, NS-Not Significant

Protein

The protein content of kodo millet adai mix was higher (15.70 g/100g) than barnyard millet adai mix (14.00g/100g). During the storage the protein content declined in kodo millet (T_1) and barnyard millet instant adai mix (T_2) stored in High Density Polyethylene bag than Metallised polyester polyethylene laminate pouches (MPP) and the values were 15.52 and 13.82 g and 15.56 and 13.88 g per 100 g respectively at the end of the storage. The loss in protein content was found to be more in High Density Polyethylene bag than Metallised polyester polyethylene laminate pouches (MPP) and was also. Statistically highly significant difference 0.05 per cent. Bhavani (2000) had reported a significant loss of protein in instant adai mix during

Table 3. Mean Sensory score for adai mix (0-180 days)

Nutrients	Storage period	Barnyard millet adai mix (T_2)			Kodo millet adai mix (T_1)		
		P_1	P_2	P_3	P_1	P_2	P_3
Colour	Initial	8.50	8.50	8.50	8.60	8.60	8.50
	Final	8.30	8.40	8.40	8.40	8.40	8.40
Flavor	Initial	8.50	8.40	8.50	8.40	8.40	8.50
	Final	8.20	8.30	8.40	8.30	8.30	8.40
Texture	Initial	8.40	8.40	8.50	8.40	8.50	8.50
	Final	8.30	8.30	8.40	8.30	8.30	8.40
Taste	Initial	8.50	8.40	8.60	8.40	8.30	8.50
	Final	8.30	8.40	8.50	8.30	8.30	8.50
Overall acceptability	Initial	8.80	8.70	8.80	8.70	8.70	8.80
	Final	8.60	8.60	8.70	8.60	8.70	8.80

P_1- HDPE, P2-Aluminium foil, P3- MPP,** High significant , NS-not significant

storage. Malathi (2012) reported a protein content of 8.33 g in sorghum based instant adai mix.

Crude fibre

The crude fibre content of the barnyard millet adai mix was higher than kodo millet adai mix i.e 7.78 and 6.20 g per cent respectively. A slight change was observed in the crude fibre content 6.10 g per 100 g in HDPE, 6.14 g per 100 g in aluminium foil and 6.16 g per 100 g in MPP of kodo millet adai mix and 7.69 g per 100 g in HDPE,7.72 g per 100 g in aluminium foil and 7.74 g per 100 g in MPP of barnyard millet adai mix at the end of the storage period. Among the packaging materials the retention of fibre content was better in the adai mix packed in MPP bags. But was statistically non significant 0.05 per cent was observed. Meenatchi Sundram (2005) stated that the fibre content of the stored Ready to use food mix with finger millet and sorghum showed slight change in crude fibre content (0.92-0.91 g%) and (0.54 -0.53 g %) packed in polyethylene bags.

Tannin

Tannin content of the adai mix was higher (6.25 mg and 5.70mg) in barnyard millet mix (T_2) than kodo millet (T_1). A slight change was observed in the tannin (5.45 mg for HDPE, 5.52 mg for aluminium foil, 5.62 mg for MPP in T_1 and 6.11 mg for HDPE, 6.15 mg for aluminium foil, 6.18 mg for MPP in T_2 at the end of the storage period. Karuppasamy *et al.,*(2012) stated that the tannin content of the stored millet boli mix 12.84 mg per 100 g showed a slight reduction was observed during storage.

Calcium and iron

A slight change was observed in the calcium and iron content of the small millet based instant adai mix during storage. The calcium content of the mixes packed in MPP (P_3) exhibited minimum reduction compared to HDPE (P_1). The barnyard millet (T_2) adai mix had higher iron content (7.30 mg/100g) than kodo millet mix (T_1) (5.88 mg/100g).It was decreased to 5.77 mg for HDPE, 5.80 mg for aluminium foil, 5.83 mg for MPP in T_1 and 6.21mg for HDPE, 6.23 mg for aluminium foil, 6.25 mg for MPP in T_2 but statistically non significant at the end of the storage period. Nithya (2004) stated that there was a slight reduction in the iron content of the millet nutrimix stored in polyethylene bag without vacuum and pet jar during storage which was observed in the present investigation as well.

Sensory characteristics of adai mix during storage

Table 3 shows the sensory characteristics like colour, flavour, texture, taste and overall acceptability of kodo millet adai mix scored higher value than barnyard millet adai mix at the end of the storage period (180 days). Among the packaging material, the samples packed in P_3 had retained the highly acceptable sensory properties in T_1 and T_2 including the control. The final score for colour ranged between 8.3 (T_1P_1) and 8.4 (T_2P_3), flavour ranged between 8.2 (T_1P_1) and 8.4 (T_2P_3), texture ranged between 8.3 (T_1P_1) and 8.4 (T_2P_3), taste ranged between 8.3 (T_1P_1) and 8.5 (T_2P_3) and overall acceptability ranged between 8.6 (T_1P_1) and 8.8 (T_2P_3), respectively.

Itagi *et al.*(2003) observed no apparent changes in the sensory qualities of traditional products developed from composite mix based on foxtail millet (80%) wheat (10%) and black gram dhal (10%). Hemalatha (2004) indicated that the change in the sensory qualities of the millet based instant mixes was highly influenced by the nature of the packaging material and storage condition.

Microbial load of instant adai mix during storage

Initially the total plate count in all the samples was found to be nil and as the storage day progressed, there was an increase in the microbial load. The samples that were packed in P_3 along with the antioxidant showed the minimum microbial load when compared to the samples of the P_1 and P_2 in all the treatments. This showed that the less permeable nature of the packaging material and the presence of antioxidant had checked the growth of microorganism in these samples. The final total plate count of T_0 ranged from 2.7 (T_0P_3) to 3.1 (T_0P_1),

T_1ranged from 2.0(T_1P_3) to 2.5 (T_1P_1) and T_2ranged from 1.2 (T_2P_3) to 2.2 (T_2P_1) x 10^4cfu/ g respectively.

Pragati and Singh (2003) observed minimum count of fungi in maize flour based convenience mixes, while Hemalatha (2004) reported that no significant trend was observed for changes in the bacteria, fungi and yeast during storage in millet based instant mixes.

Cost of the standardized instant mix

The cost of small millet based instant adai mix was worked out to be Rs. 8.78 (T_0), Rs. 8.23 (T_1) and Rs. 7.78 (T_2) which lesser than the commercially available adai mix.

Conclusion

The study concluded that 100 per cent incorporation of kodo millet / barnyard millet flour was highly suitable for the preparation of instant adai mix. The standardized product was comparatively more nutritious and had a shelf life of 180 days with highly acceptable quality attributes, when packed in MPP covers and stored at room temperature.

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