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Helath mix product development by incorporating the bi-product of sorghum flakes powder & pulses and its organoleptic evaluation

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Abstract
A nutritious healthy mix was developed using staple cereals and pulses, milk substitutes, almonds and cardamom. The nutritive value and cost of the developed healthy mix was found to be better than a commercial mix. Three health mixes were developed using different combinations of broken sorghum flake powder, black gram, puffed Bengal gram, green gram based healthy mixes and analysed for nutritive and selected sensory quality parameters. All the three formulations are higher overall acceptability than control sample. Over all acceptability of the black gram based healthy mix scored lesser sensory value than the other green gram and puffed Bengal gram based mixes. The blends had higher protein and mineral content in the healthy mixes (referred through calculated nutritional value of NIN) however, based on sensory data, the blends were well accepted. This indicates that though the addition of pulses and oil seeds could enhance the nutritional status of the product as well as sensory attributes. All the mixes were inexpensive and nutritious, and remained acceptable even after being stored for one month.

Keywords: bi-product, sorghum flakes powder, pulses, organoleptic evaluation

1. Introduction
Protein-energy malnutrition is an important nutritional deficiency condition that often occurs during the critical transitional phase of healthy mixes for infants, crippling their physical and mental growth. This condition can be prevented to a large extent by introducing healthy mixes of quality and quantity at the right time in the right proportions. Several commercial healthy mixes are being marketed in India, but they are too expensive for the population of low socio-economic status, especially those in the rural areas. It is therefore imperative to formulate inexpensive healthy mixes from locally available resources that can easily be prepared at home.

Millets are traditional and staple food for majority of poor people in India. Millets are extensively grown in extreme conditions because of their wider acceptability to all climates. In India, most commonly grown millets are small –grained cereals like sorghum (Jowar), pearl millet (bajra) and (ragi) finger millet (Dayakar, B. 2011) [3]. Generally, sorghum acts as a principal source of energy, protein, vitamins and minerals for millions of people especially in the semi-arid regions; playing a crucial role in the world's food economy (Hibberd, C. A. 1982) [5]. Recent findings pointed that it is a rich source of various phytochemicals, which acts as antioxidants and has potential positive impact on human health. Sorghum fractions possess high antioxidant activity *in vitro* relative to other cereals and fruits. The high demand for antioxidant and nutraceutical foods has increased during the past years to prevent oxidative stress associated to the development of chronic diseases such as cardiovascular, neuron degeneration, cancer, diabetes and hypercholesterolemia as well as being involved with the process of aging. (Awika & Rooney, 2004) [1].

Cereal flakes are popular snacks and are largely prepared from rice or corn. Flakes from S &M could be produced adapting the normal cereal flaking methods. However because of the rigid endosperm texture, nearly spherical shape and smaller size heavy duty roller flakers is essential for flaking, unlike the edge runner used for flaking of rice. The process inactivates the lipase leading to better shelf life of the product. This will be a boon to pearl millet as its products normally develop rancidity quickly. The flakes from S &M would be a new avenue for their extended utilization. The flakes could be toasted or expanded by hot air or sand which may serve as snack or supplementary food for the obese and calorie conscious people. After toasting they could be conveniently used as ingredients of muesli and such other products. (N.G Malleshi, 2010) [7].

Pulses are considered as poor man's meat due to their high protein content ranging from 20% to 40% (Mahajan and Chattopadhyay, 2000) [6]. Jowar is a coarse grain and is difficult to pound. Therefore, it was not as popular as rice flakes. But with the advent of technology, it has now become possible to produce flakes from jowar as well. It is a very popular cereal especially in rural areas of western India. Jowar flakes have many applications. Jowar flakes have several applications and they are very popular especially in Maharashtra.

In Jowar process 60 to 70% of flakes were prepared and remaining percentage was husk and broken flakes powder. Broken flakes powder was nearly 30% so that Jowar broken flakes powder was used as bi-product and can be prepared as healthy mixes.

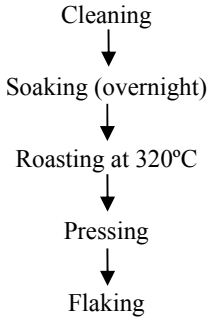
Under the National Agriculture Innovation Project (NAIP) and Directorate of Sorghum Research (DSR) has developed, standardized jowar based healthy mixes using with jowar broken flakes and different combination of pulses. Health Mix have combination of all the essential nutrients in one meal, Health Mix is the ideal family porridge. This Health Mix contains a Perfect blend of cereals, pulses and nuts are best suited for today's health-conscious consumers. It is an excellent source of high quality proteins and Vitamins that helps in preventing various nutrient deficiency disorders. Health Mix promotes overall health of the family. This paper discusses the evaluation of several experimental mixes made from a variety of locally available foods by traditional processing techniques.

2. Materials and methods

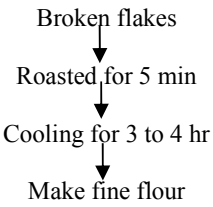
Present study was conducted to evaluate and compare sensory characteristics between the different combinations of pulses related healthy mixes prepared with jowar broken flakes. The product were standardized and developed at DSR. A white sorghum cultivar, M35-1 was selected for this study and it was procured from primary processing like winnowing, sieving, cleaning, pearling and dehulling was done and finally processed as flakes. The flakes manufacturing process was given below.

2.1 manufacturing process

Jowar grains are cleaned and soaked in water for around 12 to 16 hours. After that they are roasted and then rested to obtain wrinkle-free flakes. Grains are then pressed and flaked and sifted. Finally, flakes are dried and packed. The yield is around 60% to 70% on clean jowar basis. The process flow chart is as under:



Above processes was used and develop the flakes but while in process 60 to 70% flakes and remaining percentage was husk and flakes brokens. The broken flakes were used and develop the healthy mixes. The process of broken flakes powder given below-



2.2 Development of healthy mixes

The concept of multi mixes and a four food square system (PAG, 1977) [9] was adopted for selecting the staple protein and energy supplement. A number of permutations and combinations with the locally grown and commonly consumed food stuffs of the region were theoretically calculated for protein content, essential amino acid profile and chemical score.

Three mixes using blends of cereal, pulse and oilseeds were formulated. Sorghum broken flake powder was selected as staple foods. Among the pulses, black gram, puffed Bengal gram and green gram were used as protein supplements to the staple foods. Almonds was included as a rich source of energy, protein and ω (omega) fatty acids. Skimmed Milk powder is a very good source of protein. Cardamom was good flavour enhancer. The grains sorghum, black gram green gram and puffed Bengal gram were procured in one lot from the local market of Hyderabad.

These were cleaned for dust and other extraneous material, and stored at room temperature in a plastic container. Almonds and cardamom were also procured in one lot from the local market. Cereal, pulse and oilseed were added in the ratio so that the mixture provides essential amino acid contents similar to the milk powder protein (standard reference protein). The compositions of the mixtures are presented in Table 1.

Processing methods Boiling and roasting were employed for the processing of grains as these methods are simple in operation and improve taste, flavour and digestibility of the nutrients. The dried grains were slightly roasted in a pan to enhance the flavour and acceptability. Almonds were separately roasted and powdered. All the ingredients were finely powdered and developed healthy mixes.

2.3 Sensory Evaluation

Semi trained panelists were selected to evaluate sensory properties. Both male and female panelists about 8 members with an age range from 20 to 50 years were recruited to test for each product recipe. The tests were conducted individually with natural light. The proforma containing the questionnaire was prepared in English. The responses were recorded on a 5 point Hedonic scale (1- very poor, 2- poor, 3-good, 4- very good and 5 –excellent) for appearance, color, texture, taste, flavor and overall palatability attributes. General demographic data (name, age, sex and date of evaluation) was collected (O. Mahony 1986) [8]. The recipe for the study was coded – healthy mix-1, healthy mix-2, healthy mix-3 and control. Sample of healthy mixes was prepared with sorghum as the main ingredient and control was prepared from absence of pulses. The panelist were given sample of healthy mixes then followed by control sample. Drinking Water was provided to the panelists to cleanse the palate. All the mixes being stored for one month.

2.4 Statistical analysis

The data was subjected to the statistical analysis. Descriptive statistics like mean, standard deviation and frequency distribution were computed.

Table 1: Composition of healthy mixes (S. Chakravarthi and Rashmi Kapoor, 2003)

Ingredients	Healthy mixes			
	Black gram	Puffed bengalgram + black gram	Green gram+ black gram	Control sample
Broken flake powder	100 gm	100 gm	100 gm	100gm
Black gram	40 gm	40 gm	40 gm	-
Skimmed milk powder	50 gm	50 gm	50 gm	50 gm
Sugar	50 gm	50 gm	50 gm	50 gm
Almonds	20 gm	20 gm	20 gm	20 gm
cardamom	2 gm	3 gm	3 gm	2gm
Puffed bengal gram	-	40 gm	-	-
Green gram	-	-	40 gm	-
Ghee	10 ml	10 ml	10 ml	10 ml

3. Results and discussion

The responses of the organoleptic evaluation are given in table 2 to 4. The test foods (sorghum based) are compared with respective controls prepared healthy mixes. Here black gram based healthy mix, puffed Bengal gram healthy mix and green gram based healthy mix is compared with control healthy mix those prepared conventionally.

Table 2: Organoleptic evaluation of black gram based healthy mix (Healthy Mix-I) and control sample.

Organoleptic character	Mean score (n=8)	
	Healthy mix-I	Control
Color	3.13 ± 0.64	3.13 ± 0.64
Appearance	3.13 ± 0.64	3.13± 0.64
Texture	3.25 ± 0.46	3.25 ± 0.46
Flavor	3.50 ± 0.53	3.50 ± 0.53
Taste	3.38 ± 0.74	3.13± 0.64
Over all acceptability	3.63± 0.74	3.38 ± 0.52

(Scores: 1- very poor, 2- poor, 3-good, 4- very good and 5 –excellent)

The sensory attributes and over all acceptability of black gram based healthy mix as given in table-2. It depicts that the mean values and standard deviation values of color, appearance, taste, texture, flavor and over all acceptability of black gram based healthy mix and control sample are more or less similar. Control sample does not contain any pulses so that the sensory evaluation can be differ because pulses contain protein and improve color and over all acceptability will be improve better amount mainly.

Table 3: Organoleptic evaluation of puffed Bengal gram based healthy mix (Healthy Mix-II) and control sample.

Organoleptic character	Mean score (n=8)	
	Healthy mix-II	Control
Color	3.25 ± 0.71	3.13 ± 0.64
Appearance	3.25± 0.71	3.13± 0.64
Texture	3.25 ± 0.46	3.25 ± 0.46
Flavor	3.63 ± 0.52	3.50 ± 0.53
Taste	3.63 ±0.74	3.13± 0.64
Over all acceptability	3.75 ± 0.46	3.38 ± 0.52

(Scores: 1- very poor, 2- poor, 3-good, 4- very good and 5 –excellent)

The mean scores of the sensory attributes of puffed Bengal gram based healthy mix values are given in table-3.the mean score values are greater than the control values. Among all the above results color and appearance, texture chacteristics are same but taste, flavor and over all acceptability was differ drastically. The reason was control sample does not contain pulses and mostly roasted pulses are improve taste and over all acceptability of the product.

Table 4: Organoleptic evaluation of green gram based healthy mix (Healthy Mix-III) and control sample.

Organoleptic character	Mean score (n=8)	
	Healthy mix-III	Control
Color	3.25 ± 0.71	3.13 ± 0.64
Appearance	3.25 ± 0.71	3.13± 0.64
Texture	3.38 ± 0.74	3.25 ± 0.46
Flavor	3.75 ± 0.71	3.50 ± 0.53
Taste	3.75 ± 0.71	3.13± 0.64
Over all acceptability	3.75 ± 0.71	3.38 ± 0.52

(Scores: 1- very poor, 2- poor, 3-good, 4- very good and 5 –excellent)

The above table depicts that the mean scores of the sensory attributes of green gram based healthy mix values are greater than the control values. Among the each attribute control sample acceptability was poor because green based healthy mix contain two types of pulses these are improve over all acceptability as well as improve nutritive value content.

Table 5: Comparison of mean scores acceptability of different healthy mixes.

Sensory attributes	Mean scores of different combinations of pulse based healthy mixes			
	Healthy mix-I	Healthy mix-II	Healthy mixIII	Control
Color	3.13	3.25	3.25	3.13
Appearance	3.13	3.25	3.25	3.13
Texture	3.25	3.25	3.38	3.25
Flavor	3.50	3.63	3.75	3.50
Taste	3.38	3.63	3.75	3.13
Over all acceptability	3.63	3.75	3.75	3.38

Table 6: Attributes of different healthy mixes

Health Mixes/ Attributes	Colour	Texture	Flavour	Taste	Overall acceptable
Health mix-1	0.304	0.111	0.066	0.012	0.2
Health mix-2	0.425	0.111	0.25	0.237	0.174
Health mix-3	0.304	0.268	0.143	0.055	0.085

Table 5: R^2 values for health mixes comparison to control.

The table 4 depicts that the comparison between all the samples sensory results showed that the colour, texture and appearance of the samples three healthy mixes were very close to the standard but the colour of the black gram based healthy mix was little bit pale colour its only because of single pulse used in this sample. Pongjanta *et al.* (2006) [10] who stated that the colour values of the product increased with higher incorporation of pulses. The taste of the samples healthy mix-1, healthy mix-2 and healthy mix-3 obtained that rating is differed. Over all acceptability of the black gram based healthy mix is sensory value are lesser than the both green gram and puffed Bengal gram based mixes. *R2 values lies between 0.1 to0.5 which are in the range for all the health mixes.* All the mixes were inexpensive and nutritious, and remained acceptable even after being stored for one month.

Table 7: comparisons of calculated nutritive values of the different healthy mixes.

Proximates	Protein (gm/%)	Fat (gm/%)	Carbohydrate (gm/%)	Energy (k.cal)	Calcium (mg)	Iron (mg)
Healthy mix-I	38.10	25.28	176.97	1083.89	810.5	12.23
Healthy mix –II	46.424	27.524	200.21	1231.48	833.7	16.03
Healthy mix-III	47.904	25.860	200.93	1223.09	840.5	16.03

Reference: NIN calculated value of 2005 (C. Gopalan, *et al*. 2005)

The above table shows that the nutritive value (calculated) of the healthy mix-1 is lesser value than the healthy mix 2 and 3.the reason due to the healthy mix-1 contain only one pulse and healthy mix 2,3 contain two combination of pulses are there. Blending of more pulses is improved the nutritional value and protein content.

4. Conclusion

It conclude that most of the healthy mixes were well over all acceptability and well tolerated expected that the black gram based healthy mixes was little bit lesser acceptance. This study showed that healthy mixes are different blends of pulses. This healthy mix could be used as a beverage for the adults and a weaning drink for children. The blends had higher protein and mineral content in the healthy mixes (referred through calculated nutritional value of NIN), however, based on sensory data, the blends were well accepted. This indicates that though the addition of pulses and oil seeds could enhance the nutritional status of the healthy mixes as well as sensory attributes.

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