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# Sensory and microbiological evaluation of brown rice based weaning food

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**Abstract**
Weaning foods were formulated using varying amounts of raw materials by considering nutritive and caloric values of each ingredient in order to meet the nutrient requirement of infants. The brown rice, mungbean, apple pulp and walnut flour were blended separately in different ratios with each other along with 3 g of skim milk powder. The blended mixtures of weaning foods were packed in aluminium laminates to monitor the changes in sensory and microbial composition and were stored for a period of 6 months at ambient temperature (32 ± 2 $^0$C). On the basis of organoleptic evaluation of weaning foods, treatment $T_5$ (70:20:5:5:BR:MB:APP:WP) was adjudged as the best treatment having highest mean score of 7.98, 7.71 and 7.68 for colour, taste and overall acceptability, respectively. The highest total plate counts of $0.49\times10^2$(c.f.u/g) was recorded in treatment $T_1$(100:0:0:0:BR:MB:APP:WP) followed by $0.42\times10^2$ (c.f.u/g) in treatment $T_2$(85:5:5:5:BR:MB:APP:WP) and by $0.36\times10^2$ (c.f.u/g) was in treatment $T_3$(80:10:5:5:BR:MB:APP:WP) and the lowest of $0.14\times10^2$ (c.f.u/g) was recorded in treatment $T_7$(60:30:5:5:BR:MB:APP:WP) but within the safe limits (not more than 10,000/g) as per legal standards for cereal.

**Keywords:** Brown rice, mungbean, apple pulp powder, walnut powder, weaning food, sensory evaluation

## Introduction
Weaning foods play an important role in child growth and development when the mother's milk alone is no longer sufficient to meet the needs of child. In developing countries like India cereals and legumes are commonly available. Appropriate processing and percipient blending of locally available foods could result in improved intake of nutrients to prevent malnutrition problem (Nnam, 2002) [15]. Weaning foods are basically composed of cereals and legumes either individually or as composite gruels. Cereals and legumes are rich in nutrients and can be used in weaning foods (Aderonke *et al*., 2014) [2]. Cereals are rich in methionine and cysteine but limiting in lysine (Imtiaz *et al*., 2011) [10] whereas, legumes are rich in lysine. One of such weaning food is made from a combination of brown rice, mungbean, apple pulp powder and walnut powder. Brown rice contains the nutritional components and is also a rich source of bioactive components, such as ferulic acid, γ-oryzanol and gamma aminobutyric acid (GABA), which exists mainly in the germ and bran layers (Ohtsubo *et al*., 2005) [4]. On the other hand mungbean (*Vigna radiate* L.) is rich in dietary fibre, carbohydrates, energy, vitamins and minerals such as thiamin, iron, magnesium, phosphorus, potassium and copper. The high lysine content of mungbean makes it good complementary for rice based diets. Traditional fruits have many health benefits and especially apple pulp powder is a typical source of crude protein (6.2%), crude fat (6.8%), crude fibre (16.9%), ash (2.3%), calcium (0.06%) and phosphorous (0.06%). Walnuts are a good source of essentially fatty acids and tocopherol. In addition, walnuts have other components that may be beneficial for health including folate, tannins and polyphenols (Li *et al*., 2006). Efforts were made to develop a weaning food from brown rice, mungbean, apple pulp powder and walnut blended together in different ratios.

## Materials and Methods
Raw materials brown rice, mungbeans, apple pulp powder and walnut powder were procured from the local market of Jammu.

**Brown Rice Flour**
Brown rice was purchased from Zamindara Rice Mills, R.S. Pura, Jammu. Brown rice with intact bran was used. The rice was screened for stones and other extraneous material. It was then washed and dried. The sieved sample was then packed in airtight plastic containers and the containers were stored at room temperature until further use.

**Mungbean flour**
Mungbeans were procured from the local market of Jammu. Mungbeans (*Vigna radiata*) were thoroughly cleaned to remove extraneous material. The flour was prepared by taking cleaned mungbean seeds. After cleaning the mungbeans were washed three times in excess distilled water. Then, the cleaned and washed mungbeans were soaked in a volume of water three times the weight of seeds (3:1) for 12 hr in a container at ambient temperature. The steeping water was drained off and the soaked mungbeans were washed twice using distilled water to prevent the growth of microorganisms. The washed mungbeans were dried at 130 °C for 1 hr in an oven. The dried mungbeans were then roasted and ground in an electric grinder to make fine powder and were then packed in airtight plastic containers stored at room temperature until further use.

**Apple pulp powder**
Apple variety Red delicious was procured from local market of Jammu. Apples were thoroughly washed to remove dirt, dust, pesticide residues and microflora on the surface of the fruit. After washing the apples were peeled, cored and sliced. For obtaining the homogenized pulp the apples were crushed with the help of home-scale mixer-cum-juicer. The pulp was dried in an oven at 55 $^0$C for 3hrs and the dried pulp was ground into powder and packed in airtight containers for further use.

**Walnut Powder**
Walnuts were procured from local market of Jammu. The walnuts were washed to remove adhering contaminants and then deshelled. The deshelled walnut were size reduced with the help of a stainless steel kitchen knife to increase surface area and then blanched by adding into boiling water and allowed standing for 5 minutes before draining. This helps to reduce the tannin content of the walnut (Adebayo-Oyetoro *et al*., 2012) [1]. The blanched walnuts were then dried in hot air oven at 60 $^0$C for 5hrs. To produce walnut flour the dried walnuts were ground and packed in airtight containers for further use.

**Formulation of weaning food**
Seven composite weaning foods were formulated using varying amounts of raw materials by considering nutrient and caloric values of each ingredient in order to meet the nutrient requirement of infants Table 1.

**Table 1:** Treatment details for weaning food

| Treatment | Brown Rice (%) | Mungbean (%) | Apple pulp powder (%) | Walnut powder (%) |
|---|---|---|---|---|
| $T_1$ | 100 | - | - | - |
| $T_2$ | 85 | 5 | 5 | 5 |
| $T_3$ | 80 | 10 | 5 | 5 |
| $T_4$ | 75 | 15 | 5 | 5 |
| $T_5$ | 70 | 20 | 5 | 5 |
| $T_6$ | 65 | 25 | 5 | 5 |
| $T_7$ | 60 | 30 | 5 | 5 |

BR: Brown rice, MB: Mungbean, APP: Apple pulp powder, WP: Walnut powder

**Sensory Evaluation**
The samples were analysed on the basis of colour, taste, consistency and overall acceptiblity by semi-trained panel (9-10 judges) using 9 point hedonic scale assigning scores 9-like extremely to 1-dislike extremely. A score of 5.5 and above was considered acceptable.

**Microbiological analysis (Total Plate Count)**
Spread plate technique, described by Palczar and Chan (1991) [16] was followed. 1 g of sample was aseptically transferred into test tube containing 9 ml of sterile water and was mixed vigorously. After mixing, 1 ml of this mixture was again transferred to a test tube containing 9 ml sterile water for further dilution. The process was continued until 3$^{rd}$diluents ($10^3$). Potato dextrose agar (PDA) was inoculated with 0.1 ml of diluted sample ($10^3$), by spread plating technique and incubated at 37 $^0$C for 24 hours. Colonies were counted and multiplied by dilution factor.

**Statistical Analysis**
The results obtained were statistically analysed using completely randomized design (CRD) and CRD factorial for interpretation of the results through analysis of variance (Gomez and Gomez, 1984) [7].

**Results and Discussion**
The sensory characteristics of developed weaning food prepared from brown rice, mungbean, apple pulp powder and walnut powder was evaluated for sensory attributes viz., colour, taste, consistency and overall acceptability (Table 2, 3, 4 and Figure 2).

**Table 2:** Effect of treatment and storage period on colour score of weaning food

| Treatment | Storage (months) | | | | Mean |
|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | |
| $T_1$(100:0:0:0:BR:MB:APP:WP) | 7.48 | 7.44 | 7.40 | 7.35 | 7.41 |
| $T_2$(85:5:5:5:BR:MB:APP:WP) | 7.65 | 7.59 | 7.53 | 7.45 | 7.55 |
| $T_3$(80:10:5:5:BR:MB:APP:WP) | 7.89 | 7.76 | 7.68 | 7.59 | 7.72 |
| $T_4$(75:15:5:5:BR:MB:APP:WP) | 8.02 | 7.97 | 7.83 | 7.78 | 7.89 |
| $T_5$(70:20:5:5:BR:MB:APP:WP) | 8.11 | 8.03 | 7.93 | 7.86 | 7.98 |
| $T_6$(65:25:5:5:BR:MB:APP:WP) | 7.81 | 7.74 | 7.66 | 7.57 | 7.69 |
| $T_7$(60:30:5:5:BR:MB:APP:WP) | 7.62 | 7.55 | 7.48 | 7.42 | 7.51 |
| Mean | 7.79 | 7.72 | 7.64 | 7.57 | |

**Table 3:** Effect of treatment and storage period on taste score of weaning food

| Treatment | Storage (months) | | | | Mean |
|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | |
| $T_1$(100:0:0:0:BR:MB:APP:WP) | 7.25 | 7.04 | 6.74 | 6.41 | 6.85 |
| $T_2$(85:5:5:5:BR:MB:APP:WP) | 7.50 | 7.27 | 7.02 | 6.72 | 7.13 |
| $T_3$(80:10:5:5:BR:MB:APP:WP) | 7.56 | 7.33 | 7.08 | 6.76 | 7.18 |
| $T_4$(75:15:5:5:BR:MB:APP:WP) | 7.61 | 7.40 | 7.15 | 6.80 | 7.24 |
| $T_5$(70:20:5:5:BR:MB:APP:WP) | 8.05 | 7.79 | 7.58 | 7.42 | 7.71 |
| $T_6$(65:25:5:5:BR:MB:APP:WP) | 7.83 | 7.63 | 7.34 | 7.06 | 7.46 |
| $T_7$(60:30:5:5:BR:MB:APP:WP) | 7.75 | 7.48 | 7.20 | 6.84 | 7.32 |
| Mean | 7.65 | 7.42 | 7.15 | 6.82 | |

**Table 5:** Effect of treatment and storage period on consistency score of weaning food

| Treatment | Storage (months) | | | | Mean |
|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | |
| $T_1$(100:0:0:0:BR:MB:APP:WP) | 6.94 | 6.83 | 6.68 | 6.41 | 6.70 |
| $T_2$(85:5:5:5:BR:MB:APP:WP) | 7.59 | 7.42 | 7.16 | 6.85 | 7.25 |
| $T_3$(80:10:5:5:BR:MB:APP:WP) | 7.62 | 7.46 | 7.19 | 6.90 | 7.29 |
| $T_4$(75:15:5:5:BR:MB:APP:WP) | 7.65 | 7.49 | 7.24 | 6.94 | 7.33 |
| $T_5$(70:20:5:5:BR:MB:APP:WP) | 7.69 | 7.54 | 7.29 | 6.98 | 7.38 |
| $T_6$(65:25:5:5:BR:MB:APP:WP) | 7.74 | 7.58 | 7.33 | 7.02 | 7.41 |
| $T_7$(60:30:5:5:BR:MB:APP:WP) | 7.79 | 7.62 | 7.37 | 7.05 | 7.45 |
| Mean | 7.57 | 7.42 | 7.13 | 6.87 | |

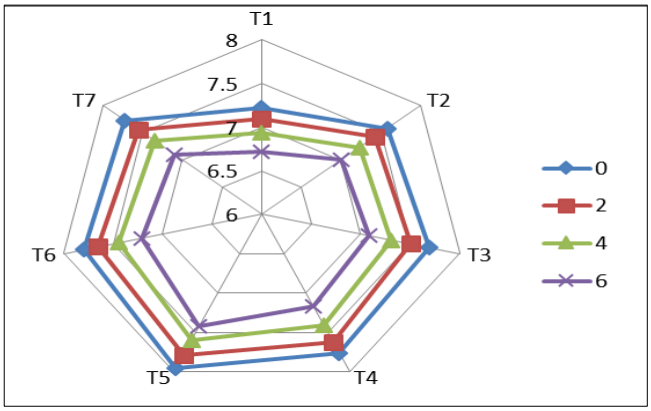


**Fig 1:** Effect of treatment and storage on overall acceptability of weaning food

Table 2, 3, 4 and Figure 1 depicts the effect of mungbean flour incorporation on the organoleptic characteristics of weaning food. With the incorporation of mungbean flour the mean colour and taste scores for weaning food showed increasing trend upto treatment $T_5$(70:20:5:5:BR:MB:APP:WP), but after that declining trend was observed. With the addition of mungbean flour, the colour scores enhanced upto 20 percent level beyond this level the colour scores followed a decreasing trend. The increase in colour and taste scores might be due to yellowish-brown colour attributed by mungbean flour and typical taste of mungbean and other ingredients. Similar results have been reported by Imtiaz *et al.* (2011) [10] in weaning food based on mungbean and wheat and Bazaz *et al.* (2016) [6] in hypoallergic weaning food based on potato, rice and green gram flour. Similarly the maximum mean value of 7.45 for consistency was recorded in $T_7$ (60:30:5:5:BR:MB:APP:WP). This might be due the high solubility index of mungbean. Bazaz *et al.* (2016) [6] also reported similar result in hypoallergic weaning food based on potato, rice and green gram flour. Panelists rated weaning food prepared from treatment $T_5$ (70:20:5:5:BR:MB:APP:WP) as best in terms of overall acceptability with score of 7.68 which decreased upto 7.43 in treatment $T_7$ (60:30:5:5:BR:MB:APP:WP). There was significant decrease in organoleptic characteristics during storage. Hemalatha and Visalakshi (2005) [8] reported the similar results in supplementary foods from cereals and legumes. Our results corroborate with that of Ahmad *et al.* (2013) [3] in weaning foods prepared from multipurpose flour and papaya powder. The decrease in the sensory scores for different characteristics of the product, irrespective of treatments during storage might be attributed to changes in their objective characteristics (Hussain, 2016) [9].

**Microbial Analysis**

Data on the microbiological characteristics of the sample are presented in Table 5. The Microbiological analysis was carried out to ascertain the safety of product for consumption.

**Table 5:** Effect of treatment and storage period on microbial count ($\times 10^3$c.f.u/g) of weaning food

| Treatment | Storage (months) | | | | Mean |
|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | |
| $T_1$(100:0:0:0:BR:MB:APP:WP) | 0.49 | 2.74 | 4.29 | 5.53 | 3.26 |
| $T_2$(85:5:5:5:BR:MB:APP:WP) | 0.42 | 2.67 | 4.12 | 5.37 | 3.14 |
| $T_3$(80:10:5:5:BR:MB:APP:WP) | 0.36 | 2.60 | 3.94 | 4.90 | 2.95 |
| $T_4$(75:15:5:5:BR:MB:APP:WP) | 0.30 | 2.52 | 3.82 | 4.78 | 2.86 |
| $T_5$(70:20:5:5:BR:MB:APP:WP) | 0.25 | 2.45 | 3.68 | 4.61 | 2.74 |
| $T_6$(65:25:5:5:BR:MB:APP:WP) | 0.19 | 2.36 | 3.53 | 4.47 | 2.63 |
| $T_7$(60:30:5:5:BR:MB:APP:WP) | 0.14 | 2.28 | 3.44 | 4.32 | 2.54 |
| Mean | 0.30 | 2.23 | 3.83 | 4.85 | |

Initially the highest mean microbial count of $3.26\times10^3$(c.f.u/g) was recorded in treatment $T_1$ (100:0:0:0:BR:MB:APP:WP) whereas, the lowest value of $2.54\times10^3$ (c.f.u/g)was recorded in treatment $T_7$ (60:30:5:5:BR:MB:APP:WP) (Table 5). The decrease in microbial load might be due to high protein content of mungbean flour and secondary metabolites that are capable of inhibiting catalytic activities of proteolytic enzymes that play essential role in biological systems, regulating proteolytic processes and participate in defense mechanisms against large number of pathogenic organisms (Lawrence and Koundal, 2002) [11]. Adebayo-Oyetoro *et al*. (2012) [1] also reported decrease in microbial count in weaning food with 15 to 45 percent level of supplementation with walnut. Similar results have been reported by Ahmad *et al*. (2013) [3] in weaning food made from multipurpose flour and papaya powder.

During 6 months of storage the mean microbial load of weaning food increased from $0.30\times10^3$to$4.85\times10^3$(c.f.u/g) (Table 5) but was less than the count of BIS specification (not more than 10000). The increase in microbial load during storage might be due to increase in moisture content of the product (Nagi *et al*., 2012) [14]. Midha and Mogra (2007) [13] also reported increase in microbial load in instant mix incorporated with full fat soy flour. Our results were also in line with Ahmad *et al*. (2013) [3] who also reported increase in microbial load in weaning food prepared from multipurpose flour and papaya powder and Sihag *et al*. (2015) [17] in weaning food based on pearl millet.

## Conclusion

A cost effective technology for the production of weaning food has been developed in this investigation by utilizing brown rice, mungbean, apple pulp powder and walnut powder. The study has shown a way for effective utilization and value addition to locally grown food commodities. The fact that these formulas are inexpensive, easily available and nutritious could make them effective in solving some of the nutrition problems facing infants and children.

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