



Sensory Evaluation of Complementary Foods Developed Using Malted Grains Flour to Overcome Malnutrition

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The growing population and their increasing demands for sustainable foods especially economic and nutritionally rich still needs to be fulfilled to overcome malnutrition in some under-developed and developing countries. Malnutrition is a major public health issue affecting mainly young children due to higher demands for nutritious and healthy foods. Therefore, this study was carried out with the objective to develop various complementary foods such as *Dalia*, *Khichdi*, *Panjiri*, Pancakes and *Seviyan* by using combination of easily available staple malted grains such as wheat, *mung* and *ragi*, along with carrot and flaxseed powder to provide nutrient density to children's diet that may be helpful to combat malnutrition. The foods were developed using different ratios of flours and evaluated for sensory properties to ascertain the acceptability of the foods. The results of the study revealed the overall acceptability scores for treatment samples such as *Dalia*, *Khichdi*,

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Panjiri, Pancakes and *Seviyan* were 7.55, 8.02, 7.74, 7.86 and 7.64, respectively. Therefore, the combination of these flours can be utilized for the development of various complementary foods in order to overcome the problem of malnutrition among young children.

Keywords: *Malnutrition; malting; sensory evaluation; complementary foods.*

1. INTRODUCTION

Malnutrition (Protein Energy Malnutrition) is the majorly occurring common disorder of nutritional inadequacy in children particularly in poor income nations. It refers to the condition that occurs when a body doesn't get adequate calories, protein, vitamins and several other vital nutrients which it requires to sustain healthy tissues and functions of organs. If there is an insufficiency in the quantity and the nutritional quality of the food being utilized, the child's growth gets disturbed attributable to nutrient inadequacies (Kumari et al., 2016; Banusha & Vasantharuba, 2014). The betterment of nutrition subsequently, is a fundamental prerequisite to reduce the higher infant and child under five death rate and confirms the appropriate physical growth, mental development and social interaction of the children and appreciable academic achievement. According to National Family Health Survey-5 (2019-21), in India the percentage of stunted, underweight and wasted children (under the five years of age) is 35.5, 32.1 and 19.3, respectively. According to a recent report of Global Hunger Index, India ranked 94 among 107 countries. It also showed stunting (37.4%) and wasting (17.3%) in children under five years of age (Khandelwal, 2020; Hubner & Arendt, 2013).

To overcome malnutrition related problems, Food based strategies are perceived as fundamental part of an urgently required comprehensive approach to improve nutritional status by enhancing the availability and utilization of nutrients to combat deficiency disorders. For the betterment of nutritional status of malnourished children, the nutritional value of various cereals and legumes which are readily available and consumed as staple foods in various parts of the country, can be further improved by germination or malting and they can complement each other if appropriately handled and blended particularly by the poor mothers at household levels during early childhood (Bala et al., 2014).

Food processing techniques such as heat treatment, germination and fermentation have been proved to improve the bio accessibility of

micronutrients from cereal grains. Malting is a food processing technique that has been employed to transform and increase the nutritional qualities of millets. Malted cereals are a vital part of everyday diet of people with diverse malting practices between countries and also differ among communities within a country. Adetokunboh et al., (2022) stated that malting caused an increment in the activities of hydrolytic enzymes, improving total sugars, amino acids content, B-group vitamins and a decrease in starch and dry matter. Various products developed from germinated grains were accounted to have a superior taste and were found softer as well as sweeter. Germination is beneficial for the activation of dormant enzymes, therefore helps to enhance the digestibility of the grains, improving availability of reducing sugars, free amino acids including lysine and γ -aminobutyric acid (GABA), bio-accessible minerals, soluble dietary fiber, phenolic compounds and improved antioxidant capacity have been noticed (Ding et al., 2016).

Cereals are the most significant contributor to the human diet all around the world and generally considered as a good source of calories, protein, minerals and dietary fibre. Malting/Germination change the principle composition of the grains which thus influences functional and nutritional components. Wheat is a staple food around the world and is the 2nd most cultivated crop worldwide. Protein quality and its amounts in wheat are essential to produce acceptable wheat flour based products such as bread, cookies and noodles. *Mung* bean is rich in protein and amino acid specifically lysine and thus can supplement cereal-based diets of humans. It has lesser saturated fat, sodium and very low cholesterol. It is furthermore a rich source of B vitamins, minerals, fiber, vitamin C and K (Hou et al., 2019). *Ragi* is considered one of the most nutritious cereals as it has low-fat content (1.3%) mainly unsaturated fat. It also contains about 65-75 percent carbohydrates, 5-8 percent protein, 1-2 percent ether extractives, 15-20 percent dietary fiber and among all cereals and millets, it contains the highest amount of calcium (344 mg) and potassium (408 mg) (Lenka et al., 2022).

Malting induces significant beneficial biochemical changes in grains. Soaking contributes to softening of the grain with increased water availability and during germination phase, synthesis of amylases, proteases and other endogenous hydrolytic enzymes occurs. With the migration of activated hydrolytic enzymes from germ to endosperm, starch and protein gets hydrolyzed to sugars and amino acids, respectively and becomes directly available to the body. Elaboration of amylases during malting is beneficial for the development of weaning food and different infant and young child formulations due to better digestibility and improved absorption of various nutrients. Proteolytic enzymes improve amino acid availability, particularly lysine, methionine and tryptophan that are lacking in cereals (Baranwal, 2017).

On the other hand, carrots are rich in carbohydrates and minerals like calcium, phosphorus, iron and magnesium. Flaxseed is developed in numerous areas of world for oil, fibre and for therapeutic usage and furthermore as dietary item as richest source of omega-3 fatty acid i.e. alpha-linolenic acid. Therefore, keeping in view the malnutrition status, food choices and nutritional needs of malnourished preschool children, the present study was designed to develop malted cereal and legume based complementary foods as alternative source with combination of malted wheat, malted *mung*, malted *ragi*, carrot powder and flaxseed powder so as to meet the energy, protein and micronutrient requirements of the malnourished children. The developed complementary foods not only focus on increasing the energy content but they will also provide micronutrients (vitamins and minerals). Micronutrients are vital for good

health, growth and development and proper functioning of body for children under-five years of age.

2. MATERIALS AND METHODS

2.1 Procurement of Raw Material

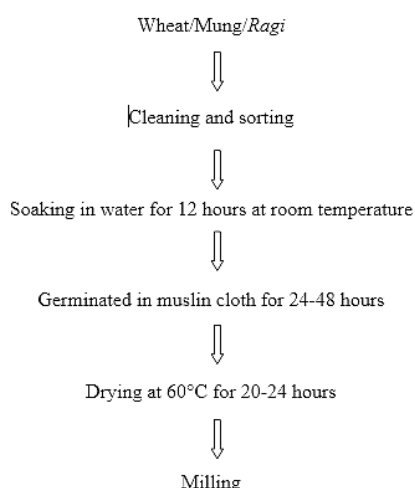
Wheat and *Mung* samples were procured from Seed Technology Center of Punjab Agricultural University, Ludhiana. *Ragi*, carrots and flaxseeds were procured from local market, Ludhiana. After procurement, processing of raw ingredients was done in the Department of Food Technology, RIMT University.

2.2 Preparation of Malted Wheat/*Mung*/*Ragi* Samples

The procedures followed for malting of grains are taken from Bala et al. (2014), Banusha and Vasantharuba (2013) and Desai et al. (2010).

2.3 Preparation of Carrot and Flaxseed Powder

Carrots were washed under tap water to remove dirt, then peeled and cut into slices of ½ cm thickness and blanched in hot water containing 1 percent sodium metabisulphite for 3 minutes. Blanched carrot slices were immediately cooled by exposing to cool air and then spread on drying trays and placed in air dryer at 50°C for 12 hours. After drying, the fine powder was obtained (Phebean et al., 2017). The flaxseeds were sorted and dry roasted in open pan for 5-7 minutes till they started to crackle and then cooled down and ground to get fine powder (Marpalle et al., 2014).



Flow Chart 1. Preparation of malted Wheat/*Mung*/*Ragi* samples

2.4 Development and Sensory Evaluation of Complementary Foods

Complementary foods such as *Dalia*, *Khichdi*, *Panjiri*, Pancakes and *Seviyan* were developed by using various combinations of malted wheat, *mung*, *ragi* flours along with carrot and flaxseed powder. The amount of flours used for the preparation of control 1 (C1), control 2 (C2) and treatment (T1, T2, T3 and T4) samples are given in Table 1 for various complementary foods. The other raw ingredients used for preparation of such complementary foods were salt, black pepper, turmeric powder, ghee, cumin seeds, powdered sugar, oil, butter, milk, baking powder, etc. The developed foods were then sensorily evaluated by a panel of 10 semi-trained judges using a nine-point hedonic rating scale to ascertain the acceptability of developed complementary foods. The traditional home based recipes for different complementary foods are given below:

***Dalia*:** Broken wheat, *ragi* and *mung* grains were dry roasted in a pan. After roasting, carrot and flaxseed powders were added. Required amount of water was added along with salt and pepper and stirred well to prevent lumps. *Dalia* was cooked for 20-25 minutes on a medium flame to get a desirable consistency.

***Khichdi*:** Rice and *mung* was soaked in warm water for 30 minutes. Ghee was heated in a pan and cumin seeds were roasted in it till crackling stage. Then chopped onions and tomatoes were sauted in it and all the spices were added along with malted wheat flour, malted *ragi* flour, carrot and flaxseed powder. Mix well and *khichdi* was cooked for 20-25 minutes with cover on pan after adding soaked rice, *mung* and water.

***Panjiri*:** Ghee was heated in a pan and flours were roasted until they turned golden brown. After roasting, flours were cooled and sugar was added and mixed well.

Table 1. Composition of flours in various treatment samples of complementary foods

Food	Flours	C1	C2	T1	T2	T3	T4
<i>Dalia</i>	Raw Wheat (g)	100	-	-	-	-	-
	Malted Wheat (g)	-	100	70	70	70	70
	Malted <i>Mung</i> (g)	-	-	12.5	10	7.5	5
	Malted <i>Ragi</i> (g)	-	-	12.5	10	7.5	5
	Carrot Powder (g)	-	-	2.5	5	7.5	10
	Flaxseed Powder (g)	-	-	2.5	5	7.5	10
<i>Khichdi</i>	Rice (g)	50	50	45	40	35	30
	Malted wheat (g)	-	-	2.5	5	7.5	10
	Malted <i>Ragi</i> (g)	-	-	2.5	5	7.5	10
	Split <i>Mungdal</i> (g)	50	-	-	-	-	-
	Malted <i>Mung</i> (g)	-	50	45	40	35	30
	Carrot Powder (g)	-	-	2.5	5	7.5	10
<i>Panjiri</i>	Flaxseed Powder (g)	-	-	2.5	5	7.5	10
	Raw wheat flour (g)	100	-	-	-	-	-
	Malted wheat flour (g)	-	100	90	80	70	60
	Malted <i>mung</i> flour (g)	-	-	5	10	15	20
	Malted <i>ragi</i> flour (g)	-	-	0.5	1	1.5	2
	Carrot powder (g)	-	-	2	4	6	8
Pancakes	Flaxseed powder (g)	-	-	2.5	5	7.5	10
	<i>MungDal</i> (g)	100	-	-	-	-	-
	Malted <i>mung</i> (g)	-	100	90	80	70	60
	Malted wheat (g)	-	-	5	10	15	20
	Malted <i>ragi</i> (g)	-	-	1	2	3	4
	Carrot powder (g)	-	-	2	4	6	8
<i>Seviyan</i>	Flaxseed powder (g)	-	-	2	4	6	8
	<i>Besan</i> (g)	100	50	90	80	70	60
	Malted <i>mung</i> flour (g)	-	50	2.5	5	7.5	10
	Malted wheat flour (g)	-	-	2.5	5	7.5	10
	Malted <i>ragi</i> flour (g)	-	-	1	2	3	4
	Carrot powder (g)	-	-	2	4	6	8
	Flaxseed powder (g)	-	-	2	4	6	8

Pancakes: *Mung* grains were rinsed and soaked in water for 3-4 hours. Then water was discarded. Soaked *mung* was blended with some water and a smooth and lump free batter was prepared by adding all other flours. All the spices were added and mixed well and batter was kept for rest for 15-20 minutes. Water was added to make batter of pouring consistency, neither too thick nor too thin. Then a scoopful of batter was poured towards the center of the griddle and spread a little with the help of spatula giving a round and even shape. Few drops of oil were drizzled around the edges of the pancakes. Both sides of the pancakes were cooked on medium flame.

Seviyan: All the dry ingredients were mixed well with oil. Soft and smooth dough was prepared by adding little water. Dough was kneaded properly and then allowed to rest for about 15 minutes. *Seviyan* maker with attachment was greased. Enough dough was placed to fill the cylinder of *seviyan* maker and closed. Oil was heated in a frying pan. *Seviyan* maker was held over frying pan and handle was pressed to pour *seviyan* into oil and fried until they turned golden brown and oil stopped dizzling. Finally, took them out on paper towel lined plate and cooled down to make them crispy.

2.5 Statistical Analysis

Data conducted was statistically analyzed by using SPSS software. Mean and Standard error was calculated for all parameters. Mann Whitney and Kruskal Wallis test was applied to compare the results of organoleptic evaluation of foods and to determine the significant difference of the independent variables.

3. RESULTS AND DISCUSSION

3.1 Sensory Evaluation of Developed Complementary Foods

The complementary foods were evaluated for sensory acceptability by using nine-point hedonic rating scale. Various sensory attributes such as appearance, texture, colour, taste, flavour and overall acceptability of such complementary foods were evaluated and the mean of the scores for different parameters of various complementary foods are discussed below:

Dalia: The mean scores of acceptability trial for *dalia* given by panel of judges are presented in Table 2. The results revealed that in case of appearance treatment T1, T2 and T3 i.e. 7.5, 7.4

and 7.0 were found non-significantly different from C1 (7.7) and C2 (7.6) and T4 with scores of 6.4 was significantly ($p < 0.05$) different from all the control and treatment samples. Colour parameter of treatment T1 (7.6) was found non-significantly ($p > 0.05$) different from both control samples and other treatments except T4 (6.5). In case of texture, flavour and taste T1 scored highest i.e. 7.65, 7.55 and 7.45, respectively having non-significant ($p > 0.05$) difference with control (C2) with the scores of 7.6, 7.5 and 7.4 and C1 with scores of 7.8, 8.0 and 7.9, respectively. The overall acceptability scores were found to be highest for treatment T1 (7.55) following C1 (7.84) and C2 (7.56) and then followed by T2 (7.22), T3 (6.9) and T4 (6.22). Significant ($p < 0.05$) variation was observed in all the sensory parameters of treatment T4 in comparison to both control samples. The increased level of carrot and flaxseed powder affects the sensory quality of developed products. Bala et al. (2014) conducted a study with the objective to develop and analyze sensorily the four blends of composite weaning foods with the use of malted cereals, legumes, oilseed and vegetable powder. Malted wheat and lentil flour, carrot and potato flour and linseed were used at various levels. The results revealed that there were significant ($P < 0.05$) differences in overall acceptability score of all the blends. T3 (Malted wheat flour: Malted lentil flour: Potato, 45:25:15) was liked very much while T1 (Malted wheat flour: Malted lentil flour: Potato, 35:30:20), T2 (Malted wheat flour: Malted lentil flour: Potato, 40:25:20) and T4 (Malted wheat flour: Malted lentil flour: Potato, 50:20:15) were liked moderately by the judges. Similar findings were obtained in another study conducted by Adhikari and Twayanbasu, (2014). Weaning foods were prepared using malted wheat, *mung* bean, sweet potato and banana and physicochemical analysis was carried out. The formulation including malted wheat (30): *mung* bean (50): sweet potato (10): banana (10) was preferred by panelists on the basis of sensory evaluation.

Khichdi: The data regarding the sensory scores of *khichdi* (Table 3) stated that best scores were obtained by treatment T1 following control (C2 and C1) for all sensory parameters. In case of appearance, treatment T1 was found to have similar scores of 8.1 as control samples and showed non-significant difference. Significant ($p < 0.05$) difference was observed in appearance of other treatment samples and control samples. Treatment T2, T3 and T4 showed significant ($p < 0.05$) variation to that of C1 (8.1) and C2 (8.1)

in colour with scores of 7.5, 7.2 and 7.1. In case of texture and flavour, non-significant difference was observed in treatment T1 (7.9, 8.0) and T2 (7.6, 7.8) when compared with control samples and T3 and T4 showed significant ($p<0.05$) difference with the values of 7.4, 7.4 and 7.3, 7.3, respectively. Similar results were obtained in case of taste of treatment T1 (8.0) which were found non-significantly different from C1 (8.2) and C2 (8.2). The overall acceptability scores were found to be highest for treatment T1 (8.02) with non-significant difference to that of control samples and then followed by treatment T2

(7.64), T3 (7.32) and T4 (7.22) with significant ($p<0.05$) difference to control and treatment T1. Gaddam et al. (2016) developed a food with the combination of *ragi* malt (finger millet malt) and oats flour to provide complementary health benefits. Malt of *ragi* was mixed with oat flour at various levels such as 10, 20 and 30 percent, respectively and developed products were evaluated for sensory analysis using 5 point hedonic rating scale by a panel of 30 members and results revealed that formula 1 containing 10 percent oats flour scored highest than all other samples.

Table 2. Sensory scores for malted flours based *Dalia* (Mean \pm SE)

Levels	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
C1	7.7 ^a \pm 0.39	7.8 ^{ac} \pm 0.38	7.8 ^a \pm 0.35	8.0 ^a \pm 0.33	7.9 ^a \pm 0.37	7.84 ^a \pm 0.36
C2	7.6 ^a \pm 0.22	7.7 ^c \pm 0.21	7.6 ^a \pm 0.22	7.5 ^{ac} \pm 0.16	7.4 ^{ac} \pm 0.22	7.56 ^a \pm 0.15
T1	7.5 ^a \pm 0.22	7.6 ^{ac} \pm 0.22	7.65 ^a \pm 0.21	7.55 ^{ad} \pm 0.21	7.45 ^{ad} \pm 0.26	7.55 ^a \pm 0.20
T2	7.4 ^a \pm 0.16	7.4 ^{ac} \pm 0.16	7.3 ^{ac} \pm 0.15	7.10 ^{cd} \pm 0.17	6.9 ^{cd} \pm 0.27	7.22 ^a \pm 0.15
T3	7.0 ^{ac} \pm 0.25	6.9 ^{ab} \pm 0.23	7.0 ^{ac} \pm 0.25	6.9 ^{bcd} \pm 0.31	6.7 ^{bcd} \pm 0.36	6.9 ^{ac} \pm 0.26
T4	6.4 ^{bc} \pm 0.30	6.5 ^b \pm 0.30	6.6 ^{bc} \pm 0.30	5.9 ^b \pm 0.34	5.7 ^b \pm 0.33	6.22 ^{bc} \pm 0.27
χ^2 value	11.50*	13.66*	11.04 ^{NS}	20.98**	19.24**	17.03**

**Significant at 1% level of significance ($p<0.01$)

*Significant at 5% level of significance ($p<0.05$)

NS - Non Significant

Means with different notations (a, b, c and d) indicates significant difference at 5% level of significance

Table 3. Sensory scores for malted flours based *Khichdi* (Mean \pm SE)

Levels	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
C1	8.1 ^a \pm 0.10	8.1 ^a \pm 0.10	8.0 ^{ac} \pm 0.21	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.12 ^a \pm 0.12
C2	8.1 ^{ac} \pm 0.17	8.1 ^a \pm 0.17	8.1 ^a \pm 0.17	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.14 ^a \pm 0.14
T1	8.1 ^a \pm 0.10	8.1 ^a \pm 0.10	7.9 ^{acd} \pm 0.17	8.0 ^a \pm 0.14	8.0 ^{ac} \pm 0.14	8.02 ^{ac} \pm 0.11
T2	7.6 ^{bc} \pm 0.16	7.5 ^b \pm 0.16	7.6 ^{acd} \pm 0.26	7.8 ^{ac} \pm 0.20	7.7 ^{bc} \pm 0.15	7.64 ^{bc} \pm 0.14
T3	7.2 ^b \pm 0.24	7.2 ^b \pm 0.20	7.4 ^{cd} \pm 0.22	7.4 ^{bc} \pm 0.22	7.4 ^b \pm 0.22	7.32 ^{be} \pm 0.14
T4	7.1 ^b \pm 0.23	7.1 ^b \pm 0.17	7.3 ^{bd} \pm 0.21	7.3 ^{bc} \pm 0.21	7.3 ^b \pm 0.21	7.22 ^{de} \pm 0.12
χ^2 value	23.63**	28.49**	10.66 ^{NS}	18.64**	20.20**	27.307**

**Significant at 1% level of significance ($p<0.01$)

*Significant at 5% level of significance ($p<0.05$)

NS - Non Significant

Means with different notations (a, b, c and d) indicates significant difference at 5% level of significance

Table 4. Sensory scores for malted flours based *Panjiri* (Mean \pm SE)

Levels	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
C1	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13
C2	8.2 ^a \pm 0.13	8.2 ^a \pm 0.13	8.1 ^a \pm 0.10	8.0 ^{ac} \pm 0.14	8.0 ^{ac} \pm 0.14	8.1 ^a \pm 0.11
T1	7.8 ^a \pm 0.20	7.8 ^a \pm 0.20	7.9 ^{ac} \pm 0.17	7.6 ^c \pm 0.16	7.6 ^c \pm 0.16	7.74 ^a \pm 0.16
T2	7.1 ^b \pm 0.23	7.0 ^b \pm 0.25	7.5 ^{bc} \pm 0.16	6.7 ^b \pm 0.30	6.6 ^b \pm 0.26	6.98 ^b \pm 0.20
T3	6.5 ^b \pm 0.26	6.4 ^b \pm 0.26	7.1 ^b \pm 0.23	6.2 ^b \pm 0.29	6.2 ^b \pm 0.29	6.48 ^b \pm 0.22
T4	6.4 ^b \pm 0.26	6.4 ^b \pm 0.26	7.1 ^b \pm 0.31	6.1 ^b \pm 0.27	6.1 ^b \pm 0.27	6.42 ^b \pm 0.24
χ^2 value	36.05**	36.05**	21.95**	36.53**	38.12**	37.87**

**Significant at 1% level of significance ($p<0.01$)

*Significant at 5% level of significance ($p<0.05$)

NS - Non Significant

Means with different notations (a, b, c and d) indicates significant difference at 5% level of significance

Panjiri: The results for sensory evaluation of *panjiri* revealed that treatment T1 obtained highest overall acceptability scores 7.74 with non-significant difference to that of both control samples (Table 4). Significant ($p < 0.01$) variation was observed in colour, appearance, texture, taste, flavour and overall acceptability of T2, T3 and T4 samples when compared with control samples. Treatments such as T2, T3 and T4 showed non-significant difference among themselves with overall acceptability scores of 6.98, 6.48 and 6.42. Non-significant difference was observed in texture of T1 and T2 with the values of 7.9 and 7.5. The results were supported by Srivastava et al. (2015) who conducted a study for developing weaning food by using germinated cereals and pulses flours and then organoleptic evaluation along with nutritional analysis of developed product was conducted. Flours of wheat, *moong* and *bajra* were mixed at various proportions for the preparation of sweet porridge and coded as T1, T2 and T3. The results for sensory analysis showed that T3 (20:15:65) scored highest in overall acceptability amongst all other treatments and it was concluded from the study that germinated grains flour can be effectively incorporated in weaning food. Similarly, composite flour mix was developed by Sharma et al. (2018) using whole wheat flour, malted sorghum flour, malted *khesari dal* flour, flaxseed powder and sweet potato flour at different ratios. The products formulated from sorghum based composite flour mix possess enormous functional properties in terms of protein, minerals, crude fibre and phytonutrients principally phenolic compounds like total flavonoids and total phenolics with strong antioxidant capability. In T4 samples, the scores for appearance, colour, flavor and taste were decreased that might be due to the incorporation of more flaxseed powder. Extended storage of flaxseed can result in its deterioration and generation of methionine

oxidation of its cyclolinopeptides, responsible for the bitter taste of flaxseed (Stamenkovic et al., 2019).

Pancakes: The results obtained in case of sensory evaluation of pancakes are presented in Table 5. The scores for appearance and colour were found to be highest in T2 treatment (7.9 and 7.9) after C1 (8.1 and 8.1) and C2 (8.1 and 8.1) respectively. Treatment T2 was found to be highly acceptable after control (C1 and C2) pancakes with non-significant difference in case of all the sensory attributes. The treatment T1 and T2 showed non-significant difference with control samples having scores of 7.7 and 7.9 for colour, 8.0 and 7.7 for texture, 7.9 each for flavour and taste. Significant ($p < 0.05$) difference was noticed in appearance, colour, texture, flavour and taste of T3 and T4 treatments when compared with control samples. The overall acceptability scores for C1, C2, T1, T2, T3 and T4 were found 8.1, 8.04, 7.84, 7.86, 7.32 and 6.7, respectively. Composite flour was prepared using soaked wheat flour, *ragi* flour, *mung* flour, soya flour along with roasted groundnut flour and used to develop low cost functional homemade product, *chakli*. The basic recipe (control T0) has three variations T1, T2, T3 respectively, in which the different amounts of the flours were used and the organoleptic evaluation of *chakli* was conducted by a panel of ten judges using nine-point hedonic scale. The results indicated that the processed composite flour based product was appreciably accepted and treatment T1 of *chakli* was found best with respect to colour, taste and overall acceptability (Kumari et al., 2016).

Seviyan: The scores of sensory attributes significantly decreased with increase in ratio of malted flours and carrot and flaxseed powders (Table 6). In case of appearance, C1 was given 8.4 followed by C2 (8.1), T2 (7.55), T1 (7.45), T3

Table 5. Sensory scores for malted flours based Pancakes (Mean \pm SE)

Levels	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
C1	8.1 ^a \pm 0.23	8.1 ^a \pm 0.23	7.9 ^a \pm 0.27	8.2 ^a \pm 0.20	8.2 ^a \pm 0.20	8.1 ^{ac} \pm 0.21
C2	8.1 ^a \pm 0.10	8.1 ^a \pm 0.10	8.0 ^a \pm 0.14	8.0 ^a \pm 0.14	8.0 ^a \pm 0.14	8.04 ^a \pm 0.12
T1	7.7 ^{ac} \pm 0.21	7.7 ^{ac} \pm 0.21	8.0 ^a \pm 0.14	7.9 ^{ac} \pm 0.17	7.9 ^{ac} \pm 0.17	7.84 ^{ac} \pm 0.15
T2	7.9 ^a \pm 0.10	7.9 ^a \pm 0.10	7.7 ^a \pm 0.15	7.9 ^{ac} \pm 0.10	7.9 ^{ac} \pm 0.10	7.86 ^{ac} \pm 0.09
T3	7.1 ^{bc} \pm 0.27	7.1 ^{bc} \pm 0.27	7.5 ^{ac} \pm 0.22	7.4 ^{bc} \pm 0.22	7.5 ^{bc} \pm 0.22	7.32 ^{cd} \pm 0.21
T4	6.5 ^b \pm 0.26	6.5 ^b \pm 0.26	6.9 ^{bc} \pm 0.31	6.8 ^b \pm 0.32	6.8 ^b \pm 0.32	6.7 ^{bd} \pm 0.26
χ^2 value	25.96**	25.96**	12.59*	19.11**	18.05**	22.55**

**Significant at 1% level of significance ($p < 0.01$)

*Significant at 5% level of significance ($p < 0.05$)

NS - Non Significant

Means with different notations (a, b, c and d) indicates significant difference at 5% level of significance

Table 6. Sensory scores for malted flours based Seviyan (Mean±SE)

Levels	Appearance	Colour	Texture	Flavour	Taste	Overall Acceptability
C1	8.4 ^a ±0.16	8.3 ^a ±0.21	8.3 ^a ±0.21	8.3 ^a ±0.21	8.3 ^a ±0.21	8.32 ^a ±0.20
C2	8.1 ^{ac} ±0.17	8.1 ^{ac} ±0.17	7.9 ^{ac} ±0.17	7.8 ^{ac} ±0.13	7.8 ^{ac} ±0.13	7.94 ^{ac} ±0.14
T1	7.45 ^b ±0.21	7.35 ^b ±0.21	7.6 ^{bce} ±0.16	7.7 ^{bc} ±0.15	7.7 ^{bc} ±0.15	7.56 ^b ±0.13
T2	7.55 ^{bc} ±0.26	7.55 ^{bc} ±0.26	7.7 ^{bc} ±0.15	7.7 ^{bc} ±0.15	7.7 ^{bc} ±0.15	7.64 ^{bc} ±0.14
T3	6.5 ^d ±0.26	6.5 ^d ±0.26	7.0 ^{de} ±0.25	7.0 ^d ±0.21	7.0 ^d ±0.21	6.8 ^d ±0.17
T4	6.1 ^d ±0.27	6.2 ^d ±0.29	6.6 ^d ±0.30	6.6 ^d ±0.26	6.7 ^d ±0.26	6.44 ^d ±0.20
χ² value	34.38**	31.63**	23.34**	26.25**	25.48**	35.47**

**Significant at 1% level of significance ($p<0.01$)*Significant at 5% level of significance ($p<0.05$)

NS - Non Significant

Means with different notations (a, b, c and d) indicates significant difference at 5% level of significance

(6.5) and T4 (6.1). Non-significant difference was observed between T2 and C2 in case of all the sensory parameters but significant ($p<0.05$) difference was observed between C1 and T2. Treatment T2 was found highly acceptable after C1 and C2 by the panel of judges with the scores of 7.55, 7.55, 7.7, 7.7 and 7.7 for appearance, colour, texture, flavour and taste. Treatment T3 and T4 was found significantly ($p<0.05$) different from control in case of all the sensory attributes. The overall acceptability scores were found 8.32 for C1, 7.94 for C2, 7.56 for T1, 7.64 for T2, 6.8 for T3 and 6.44 for T4. In one study, functional bread enriched with omega-3 by using flaxseed flour in raw and roasted forms was developed. The raw and roasted flaxseed flours were incorporated in the recipe of standardized bread at 5, 10 and 15 percent levels. Sensory evaluation of the bread was carried out. The softness in crumb increased with rise in flaxseed flour levels and bread was optimised at 10g/100 g flaxseed level on the basis on sensory analysis (Marpalle et al., 2014). In another study, *ragi* noodles were prepared by using wheat and malted *ragi* flour and results from the study revealed that among all the formulations tried, noodles prepared from 70:30 ratios of flours had same sensory score as that of control (Kulkarni et al., 2012). Similarly, two types of ready-to-use (RTE) amylase rich malted mixes were formulated by using *ragi* or wheat mixed with *mungand laddu*, *kheer*, *roti* and *porridge* were reformulated and analyzed for overall acceptability. The results of organoleptic evaluation for almost all the treatments were found between good to very good (Khader and Maheswari, 2015).

4. CONCLUSION

The results for sensory evaluation of developed complementary foods revealed that the inclusion of malted flours along with carrot and flaxseed powders in all the foods were found acceptable

in terms of all the sensory attributes however the scores were decreased with the increase in carrot and flaxseed powders. The highest overall acceptability mean scores found for *dalia*, *khichdi*, *panjiri*, pancakes and *seviyan* were 7.55, 8.02, 7.74, 7.86 and 7.64 amongst all treatment samples. Out of all developed complementary foods, treatment T1 was found highly acceptable in case of *dalia*, *khichdi* and *panjiri* and treatment T2 was found highly acceptable in pancakes and *seviyan*. Hence, the combination of malted wheat, *ragi*, *mung*, carrot and flaxseed powder can be utilized to develop nutritious infant and complementary foods and can be used in traditional foods to make them nutritionally dense and can be beneficial in improving the nutritional status of vulnerable groups of malnutrition in poor nations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that none of the AI tools have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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