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Research Paper

Development of Multigrain Mixes for *Thalipeeth* from Finger Millet Malt, Moth Bean Malt and Drumstick (*Moringa sp.*) Leaf Powder

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ABSTRACT

In this paper the effect of incorporation of multigrain mixes from finger millet malt and moth bean malt on the various physico-chemical quality characteristics and sensory score of *thalipeeth* was evaluated. The multigrain mixes was prepared by using the finger millet malt : moth bean malt at 16:36, 21:31, 26:26, 31:21, 36:16 respectively. The various quality characteristics i.e., Moisture%, Protein%, Fat%, Fibre%, Ash%, Carbohydrates%, calorific value along with the sensory attributes i.e. color, texture, taste and overall acceptability of the developed *thalipeeth* was evaluated. Response surface analysis was performed with the quality attributes indicated that multigrain mixes prepared with finger millet malt 26%, moth bean malt 26% and drumstick leaf powder results the best quality multigrain mixes have best nutritional, textural and sensory qualities. The optimal product at quality consist of %. The moisture content 5.75 %, protein 14.94 %, fat 2.14%, fibre 0.93%, ash 2.27% and carbohydrate 73.93%, calorific value 374.895 (kcal/100g), whiteness index 24.32 and have heights sensory score higher colour 8.20, taste 8.78, Texture 8.40, overall acceptability 8.4.

Keywords: Finger millet malt, moth bean malt, physico-chemical quality of multigrain mixes and sensory analysis of *thalipeeth*

Multigrain mixes prepare form various cereals and legumes like Chickpea (*Cicer arietinum*) or Bengal gram is valued for its nutritive with high protein content (20.8%), Ash(2.7%), fat(5.6%), fiber(15.3%) (Indrani, 2011). Nutritive value of rice flour, moisture (14%), ash (0.6%), crude protein (9 %), crude fat (1%), and carbohydrate (77%) (Sacchetti, 2004). Nutritive value of wheat flour, moisture (13.3%), fat (1.8%), protein (10.7%), ash (0.7%), Carbohydrate (76%) (Ribotta *et al.* 2005). The consumption of cereals and legumes all over the world gives them an important position in international nutrition. Besides the high starch and protein content as energy source, these grains provide dietary fibre, nutritious protein and lipids rich in essential fatty acids. Important micronutrients present in cereals are vitamins, especially many B vitamins, minerals, antioxidants and phyto-chemicals (Itagi and Singh, 2012). Coarse cereals includes wheat, rice, finger millet (*Eleusine coracana*), these are also termed as nutricereals because of their nutritional properties (Bouis, 2000). These nutricereals are rich sources of minerals (phosphorus, magnesium, manganese, zinc, copper,

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iron and selenium), essential vitamins (thiamin, vitamin B6, niacin, riboflavin, folate, vitamin A and vitamin E), protein, carbohydrates, dietary fiber and certain compounds such as phenolics which provides several health benefits such as proper nutrition, increased vigor against diseases and some immunomodulatary effects (Kaur *et al*. 2012).

Finger millet (*Eleusine Coracana*) also known as *ragi*. The grains are staple cereal food in some parts of Africa and India (Siwela *et al*. 2010). Finger millet belongs to the family *Poaceae* and originated in Ethiopia (Shiihii *et al*. 2011) before reaching India (Siwela *et al*. 2010). Globally, finger millet is estimated to be cultivated on an area of 4–4.5 million hectares, with a production of about 4.5 million tonnes (Guarino, 2012). The finger millet growing states in India, the highest production was obtained from Karnataka (1.2 million ton), followed by Tamil Nadu (0.224 million ton), Uttarakhand (0.174 million ton), Maharashtra (0.138 ton) and Andhra Pradesh (0.040 million ton) (Ganapathy and Patil, 2017). Finger millet is generally rich in dietary fiber and micro nutrients to prepare flour and the whole meal is utilized in the preparation of traditional foods, such as *roti* (unleavened breads), *ambali* (thin porridge) and *mudde* (dumpling) (Devi 2014). Nutritional value of finger millet, i.e., moisture (13.1g), protein (7.3g), fat (1.3g), minerals (2.7g), fiber (11.5g), carbohydrates (72.0g), carotene (42mg), thiamine (0.42mg), riboflavin (0.19mg), niacin (1.1mg) (Shobana *et al.*2013). Finger millet contains low amounts fat which contributes to reducing risks of diabetes mellitus and gastro-intestinal tract disorders (Muthamilarasan *et al*. 2016). Starch extracted from finger millet grains are used in the pharmaceutical industries in the preparation of granules for tablets and capsule dosages (Shiihii *et al*. 2011). Finger millet malt is superior to other millet malts and it is ranked next to barly (Malleshi and Desikachar, 1986). The malted and fermented ragi flour are extensively used in preparation of weaning food, instant mixes, beverages and pharmaceutical products (Rao and Muralikrishna, 2001).

Moth bean *(Phaseolus aconitifolins*) are one of the legume consumed in Northern India (Mankotia and Modgil, 2017). They are important source of proteins, carbohydrates including fiber, certain minerals (Ca, Mg, Zinc, Iron, Potassium and Phosphorus) (Salve and Mehrajfatema, 2011). Nutritive value of Moth bean *(Vigna aconitifolia*) i.e., protein (24.9%), fat (1.48%), crude fiber (4.5%), ash(2.8%), carbohydrate (60.1%) (Wabkhede and Ramteke, 1982). Legumes are generally consumed after processing into various products like milling into "dhal" puffing or roasting into snack foods, grinding into flour for different food preparations (Villegas *et al.* 2008). Starch is the major component of moth bean. Like other plant foods the digestibility of moth bean starch may also be limited by cell wall structural features (Tovar *et al*. 1991). Food legumes constitute the integral part of the diet in the Indian subcontinent. Annual production of moth bean in India 2.41 lakh ton and Maharastra 1.25 lakh ton (Kumar and Singh, 2002). The moth bean incorporated products *holige, masala vadai, nucchinundae, payasam, kharasev* were prepared by replacing the main pulse used in the basic recipe at 50 per cent level and papad at 100 per cent (Asha *et al*. 2005). Moth bean seeds have medicinal value and are used in the diets of patients suffering from fevers (Adsule, 1996). The sprouted and cooked grain is preferred as breakfast item. Fried dehusked splits are consumed in the form of dalia, a ready to eat product (Nimkar *et al*. 2005). Germination is one of the most common processes for improving the nutritional quality of pulses, not only by the reduction of antinutritive compounds also increase protein content, dietary fiber, vitamin, bioavailability of trace elements and minerals (Kaushik *et al*. 2010).

Drumstick *(Moringa oieifera),* known as miracle tree and native plant to the southern foothills of the Himalaya India, and is grown in tropical and subtropical countries and is well known for its health benefits. Leaves, flower and the fruits (popularly known as drumstick) are being used in traditional food preparation (Vanajakshi *et al.* 2015). It is the most widely cultivated species of *Moringaceae* family. Commonly it is known as in English–moringa or drumstick tree or horseradish tree, in hindi-*sahjan*, in latin- *Moringa oleifera*, in Sanskrit -*surajana*, in nepali - *sajiwan* or *swejan* etc. It is useful not only

for human beings but also for animal and also in various industrial application (Patel *et al*. 2010). Yield of leaves is approximately 55.73-15.73 tone's per hectare (Foidl *et al*. 2007). The leaves contain 7.5 mg water, 6.7 mg protein, 1.7 mg fat, 14.3 mg total carbohydrate, 0.9 mg Fibre, 2.0 mg ash, 440 mg Calcium, 70 mg Phosphorous, 7 mg Iron, 110 mg Copper, 5.1 mg, 11.300 mg vitamin A, 120 mg vitamin B, 0.8 mg nicotinic acid, 220 mg ascorbic acid and 7.4 mg tocopherol per100 mg (Fahey, 2005). Leaves of *M. Oleifera* could be used for stomach complaints, cancer, gastric ulcers, skin diseases, lowering blood sugar, increasing bone density, nervous condition, diabetes, fatigue, increase lactation, hay fever, cramps, headaches, sore gums; to strengthen the eyes and the brain, liver, gall digestive, respiratory and immune system and as a blood cleaner and blood builder (Patel *et al*. 2010). In the present investigation *thalipeeth* mixes from finger millet malt and moth bean malt is prepared, the quality analysis of the *thalipeeth* prepared from these mixes have also been studied.

MATERIALS AND METHODS

Raw material

Raw materials of Finger millet (*Eleusine coracana*) and moth bean were procured from local market, Roha Dist-Raigad (Maharastra State) and drumstick leaves were procured from the farmers field at Roha. The leaves will be washed with tap water to remove dirt, dust.

Development of Finger millet malt and moth bean malt

The finger millet malt was prepared as per the procedure described by Swami *et al.* (2013). Finger millet grain of *Dapoli*-1 variety was brought from the local market Roha. The grains were cleaned. Finger millet grains were soaked in the water 1:3 for 12hr at normal atmospheric temperature. The water was drained out and the soaked grains were placed in a muslin cloth and allowed to germinate for 24 hours. The germinated sample was removed from moist cloth after 24 hr and placed in a tray dryer at 50°C and dried up to 6 hr. Dried sample after removal of root heads was milled in the hammer mill (Make: M/ Sagar Engineering work, Kudal (India)) up to 4.541×mm particle size.

The moth bean malt was prepared as per the procedure by Rana and Kaur, 2015. Moth bean grain *ladia* variety was brough from local market Roha. The grains were cleaned and made free from dust as well as other foreign materials then seed were soaked in the water 1:3 for 12 hours. The water was drained out and the soaked grains were placed in a muslin cloth and allowed to germinate for 12 hours. The germinated sample was removed from moist cloth after 12h and placed in a tray dryer at 50°C dried up to 8 hrs. dried sample after removal of root heads was milled in the hammer mill (Make: M/ Sagar Engineering work, Kudal (India)) up to 5.4×mm particle size.

Formulation of multigrain mixes

The dried flour of finger millet malt and moth bean malt were used to formulate multigrain mixes. The formulations were made with finger millet malt and moth bean malt the concentration of finger malt : moth bean malt (W/W) was varied as 16:36, 21:31, 26:26, 31:21 and 36:16 respectively. The other ingredient with seasoning of spices i.e., cumin 3%, chilli 1%, salt 2.6%, garlic 1%, drumstick leaf powder 1% and grain like gram flour 10%, wheat flour 10%, rice flour 18 % respectively were considered 48 % remains the same in all formulations. Table 1 shows various levels of experiment using the multigrain mixes.

Table 1: Experimental level of multigrain mixes for *thalipeeth* and *sev*

Sl. No.	T1	T2	T3	T4	T5
Finger millet malt	16	21	26	31	36
Moth bean malt	36	31	26	21	16
Other ingredients	48	48	48	48	48

Other ingredients are drumstick leaf powder 1%, wheat flour 10%, rice flour 18%, chickpea flour 10%, chili 1%, cummin 3%, garlic 1%, salt 2.6%).

Physico-chemical analysis of multigrain mixes:

1. Moisture Content

The moisture content of multigrain mixes for treatment T1 – T5 were determined by AOAC (2010). 10 g sample of the multigrain mixes was taken for determination of moisture content in to each three different moisture boxes. The initial weight of moisture box was recorded. The samples were exposed to 105˚C ± 1˚C for 24 hr. in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136). The final weight was recorded. The moisture content of the sample were determined by equation (1). The experiment was repeated four times and average reading was reported.

$$\text{Moisture content \% (db)} = \frac{W1 - W2}{W2} \times 100 \quad \ldots(1)$$

Where,

*W*1= weight of sample before drying.

*W*2= weight of sample after drying.

2. Protein

Protein content in the multigrain mixes was determine for treatment T1 – T5 by a micro-Kjeldahl distillation method (AOAC 1990). The samples were digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, potassium sulphate (K_2SO_4) and copper sulphate (C_uSO_4). The mixture was made alkaline with 40% NaOH, Ammonium sulphate thus formed were released ammonia which was collected in 4% boric acid solution and titrated again with standard HCL. The percent nitrogen content of the sample was calculated the formula given below equation (2). The experiment was repeated four times and average reading was reported.

$$\text{\% (N)} = 1.4 \times (\text{ml HCl} - \text{ml blank}) \times \text{Conc. of } \frac{HCL}{Weight} \text{ of sample (g)} \quad \ldots(2)$$

$$\text{\% Protein} = \text{\% N} \times \text{Factor (6.25)} \quad \ldots(3)$$

3. Fat (%)

Fat contain of sample multigrain mixes was for treatment T1 – T5 determined using soxhlet fat extraction system (AOAC, 2010). In this method, initially weight of empty flask was weighed. 2g of sample was wrapped in filter paper. It was kept in siphoning tube and condenser was fixed above it and siphoned for 9 to 12 times with the petroleum ether in soxhlet apparatus. After removing assembly, evaporation of petroleum ether was allowed by heating round bottom flask. Residue reminder at the bottom of the flask and was reweighed with flask. The quantity of residue was determined as fat content of multigrain mixes. Fat content was calculated by using equation (4). The experiment was repeated four times and average ready was reported.

$$\text{\% Fat} = \frac{Final\ weigh - Initial\ weight}{Weight\ of\ sample} \times 100 \quad \ldots(4)$$

4. Fibre (%)

Fibre contain of multigrain mixes for treatment T1 – T5 was determined using about 2 – 5 g of moisture and fat free sample was weighed into a 500 ml beaker and a 200 ml of boiling 0.25 N sulphuric acid was added to the mixture and boiled for 30 min keeping the volume constant by addition of water at frequent intervals. The mixture was filtered through a muslin cloth and then transferred to the same beaker and 200 ml of boiling 0.313 N (1.25 %) NaOH was added, after boiling for 30 min, the mixture was filtered through muslin cloth. The residue was washed with hot water till it is free from alkali, followed by washing with alcohol and ether. It was then transferred to crucible, dried overnight at 80⁰C to 100⁰C and weighed. The crucible was heated in muffle furnace at 525⁰C for 2 – 3 hrs, cooled and weighed again. The difference in the weights represented the weight of crude fibre equation (5) Rangana (1986). The experiment was repeated four times and average reading was reported.

$$\text{Crude Fiber}\left(\frac{\text{g}}{100\text{g}}\right) = \frac{100 - (\text{Moisture} + \text{Fat}) \times \frac{\text{Weight of Fiber Weight}}{\text{Weight of sample taken}}}{(\text{Moisture} + \text{Fat free sample})} \times 10 \quad \ldots(5)$$

5. Ash (%)

Ash content of sample multigrain mixes for treatment T1 – T5 was calculated using muffle furnance. 5 g of sample was taken in crucible. Weight of crucible and sample was recorded and kept in muffle furnace at 525 ºC for 4 -5 h till constant weight was achieved. The crucible was cooled in desiccators and final weight of ash and crucible was recorded. Ash content was calculated by using equation (6). The experiment was repeated three times the average ash content was reported.

$$\text{Ash content (\%)} = \frac{(W2 - W1)}{(weight\ of\ sample)} \times 100 \quad \ldots(6)$$

Where,

W_2 = weight of crucible + ash,

W_1 = weight of empty crucible.

6. Carbohydrates (%)

The carbohydrate content of multigrain mixes were calculated from protein, fat, fibre, ash and moisture content by using equation (7) (Adegunwa *et al*. 2012)

Carbohydrates = 100 – (%protein + %fat + %fiber + %ash + %moisture content) …(7)

7. Colour

The multigrain mixes as per treatment T_1-T_5 were used to measure the colour value using a colorimeter (M/s Konica Minolta, Japan Model - Meter CR-400). The equipment was calibrated against standard white tile. Multigrain mixes and *thalipeeth* were taken in the petri dish, the petri dish was placed at the aperture of the instrument. The colour was recorded in terms of *L* = lightness to darkness; *a* = Redness to Greeness ; *b* = yellowness to blueness.

The whiteness index (WI) was determined for multigrain mixes.

Whiteness index was calculated by the following equation (8) of Park, (1994):

$$\text{Whiteness index} = [(100 - L)]^2 + a^2 + b^2]^{(1/2)} \quad \ldots(8)$$

L= lightness (100) to darkness (0)

a = redness (+60) to Greeness (-60)

b = yellowness (+60) to blueness (-60)

9. Calorific value (kcal/100g)

Calorific value of multigrain mixes for treatment T1, T2, T3, T4, and T5 for multigrain mixes from finger millet malt and moth bean malt as follows. Calculation method involved multiplication of percent fat, protein and carbohydrates (excluding dietary fiber) by their physiological energy change coefficients (as full energy of combustion is not available in human body), i.e., 9.0, 4.0 and 4.0 kcal/g, respectively, followed by their subsequent addition (FAO, 2003) Total calories of the multigrain mixes were calculated by the formula of James as follows:

Total calories = Fat × 9 + protein × 4 + Total carbohydrate × 4 …(11)

10. Sensory Evaluation

The sensory attribute of *Thalipeeth* for treatment T1 – T5 was evaluated with semi-trained panelists. The panelists were trained for the product testing and were familiar with product sensory evaluation. *Thalipeeth* samples were placed in plates. The *Thalipeeth* prepared from all the treatments and control sample were coded from A to F there were around 6 different samples out of which 5 no. of samples were from the different treatments and one treatment was of control. Which were made from various treatment combinations T1 and T5 as given in Table 2. The sensory parameters i.e. colour, taste, texture and overall acceptability were evaluated based on the Nine-point hedonic scale and the attribute were summed up for total score of each

panelist the data were analyzed statistically for the significance of each attribute by ANOVA.

10. Correlation of the quality parameter i.e. subjective and objective tests

The optimum product quality of *Thalipeeth* was determined based on the desirable quality attribute i.e. *Thalipeeth* should have more protein, low fat, more fibre, more ash, more carbohydrate, more calorific value was compared with the best sensory attribute, the best treatment were judged by the sensory panellist. The best treatment was decided based on both subjective and objective tasts and correlated the optimum product quality with the subjective quality evaluation.

RESULTS AND DISCUSSION

This chapter includes results of experimental observations and discussion based on these results. It includes Development of *Thalipeeth* from multigrain mixes with levels and incorporation as finger millet malt : moth bean malt (16:36%, 21:31%, 26:26%, 31:21%, 36:16%). Physico-chemical properties of *Thalipeeth* from multigrain mixes are reported.

Protein

The Fig. 1 shows the protein content for multigrain mixes using finger millet malt and moth bean malt. The protein content was in the range of 13.07 to 14.94 %, it was 13.07, 13.97, 14.94, 14.04, 14.30% for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest protein content was observed for treatment T_3 and lowest protein content was observed at treatment T_1. As finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the protein content shows gradually increases. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the protein content (%) of multigrain mixes for finger millet malt at $p \leq 0.05$ can be seen from Table 2(a). Itagi and Singh, (2012) reported that protein content of multigrain mixes using Cereals and millets (rice, wheat, ragi, pulses-whole chickpea, whole green gram, puffed bengal gram, defatted soya powder, nuts and oil seeds, almond, cashew nut, sesame, condiments poppy seeds) 14.8%. Verma, (2017) reported that increases protein content in multigrain mixes (Maize, Brown rice, Oats, Ragi, Bengal gram) 13.79 %.

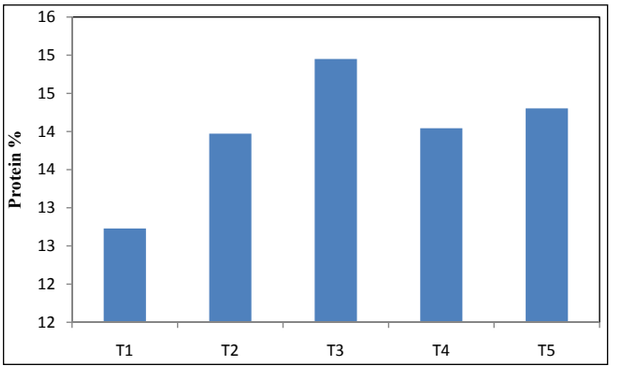

Fig. 1: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on protein content of multigrain mixes

Table 2: Physico-chemical properties of multigrain mixes

Sl. No.	Parameter	T_1	T_2	T_3	T_4	T_5	SE (±)	CD $_{at}$ p<0.05
a)	Protein	13.078±0.971	13.971±0.010	14.949±0.054	14.042±0.053	14.302±0.462	1.0786	3.251
b)	Fat	1.415±0.487	1.105±0.203	2.149±0.155	1.269±0.462	1.602±0.323	0.788	2.867
c)	Moisture content	4.960±1.080	5.013±0.615	5.750±0.957	5.284±0.559	5.501±0.560	2.187	6.593
d)	Fiber	0.794±0.079	0.805±0.061	0.939±0.043	0.897±0.002	0.898±0.073	1.078	3.251
e)	Ash	1.803±0.540	1.773±0.538	2.273±0.729	1.470±0.729	1.871±1.436	1.934	1.938
f)	Carbohydrate	77.950±2.154	77.331±1.943	73.937±1.297	77.035±0.281	75.824±1.503	89.022	268.343
g)	Whiteness index	17.746±0.005	24.373±0.318	24.325±0.318	25.666±0.506	23.790±0.906	1.094	3.299
h)	Calorific value	376.842±5.730	375.156±7.599	374.895±5.359	375.735±3.783	374.927±4.814	12.521	37.743

Fat

The Fig. 2 shows the fat content for multigrain mixes using finger millet malt and moth bean malt. The fat content was in the range of 1.105 to 2.149 %, it was 1.41, 1.10, 2.14, 1.26, 1.60 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest fat content was observed for treatment T_3 and lowest fat content was observed at treatment T_2. The finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the fat content shows gradually increasing trend upto T_3 to followed by decreasing trend upto T_5. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the fat content (%) of multigrain mixes for finger millet malt at $p \leq 0.05$ can be seen from Table 2(b). Singh *et al*. (2013) reported that 1.2 to 2.5% increases fat content of multigrain mixes prepared form sorghum, pearlmillet and maize. Rana *et al*. (2015) reported that fat content was 2.36% for multigrain dalia prepared from wheat, gram.

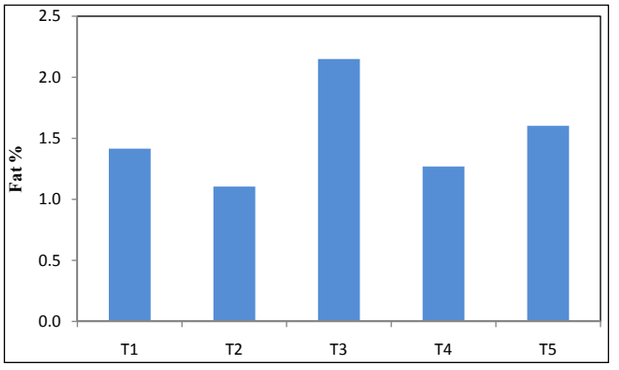

Fig. 2: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on fat content of multigrain mixes

Moisture content

The Fig. 3 shows the moisture content for multigrain mixes using finger millet malt and moth bean malt. Moisture content was in the range of 4.960 to 5.750, it was 4.960, 5.013, 5.750, 5.284, 5.501 % for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest moisture content was observed for treatment T_3 and lowest moisture content was observed at treatment T_1. As the finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the fat content shows gradually increasing trend from T1-T3 followed by decreasing trend. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the moisture content (%) of multigrain mixes for finger millet malt at $p \leq 0.05$ can be seen from Table 2(c). Srivastava *et al*. (2014) reported that moisture content of multigrain mixes (soya semolina, chickpea, barley, wheat flour) 6.5%. Pradeep *et al*. (2014) reported that moisture content of multigrain ready -to-eat snack mixes from minor cereals 5.1%. Kadam *et al*. (2012) reported that moisture content of composite flour prepared from wheat flour, chickpea flour, soybean flour and methi leaves powder was 8.1%.

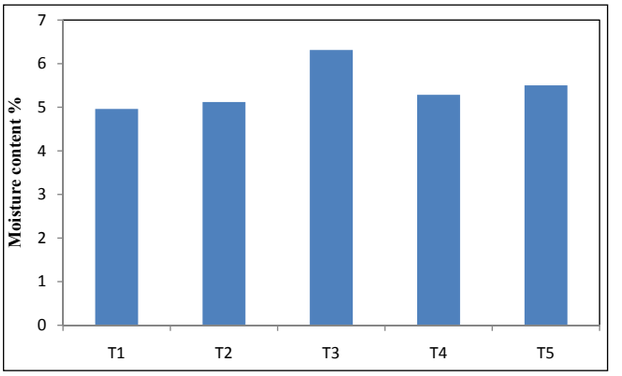

Fig. 3: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on moisture content of multigrain mix

3.4. Fiber:

The Fig. 4 shows the fiber content for multigrain mixes using finger millet malt and moth bean malt. The fiber content was in the range of 0.794 to 0.939 %, it was 0.794, 0.805, 0.939, 0.897, 0.898 % for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest fiber content was observed for treatment T_3 and lowest fiber content was observed at treatment T_1. As the finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the fiber content gradually increasing from T_1-T_3. followed by decreasing trend. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the fiber content (%) of multigrain mixes for finger millet

malt at $p \leq 0.05$ can be seen from Table 2(d). Verma, (2014) reported that fiber content of multigrain mixes prepared from brown rice, oat, ragi, chickpea, maiz, refined wheat flour, spirulina powder 2.3 %. Arya and Gaikwad, (2017) reported that fiber content of multigrain mixes prepared from sorghum, wheat, chickpea, black gram flour 0.9%.

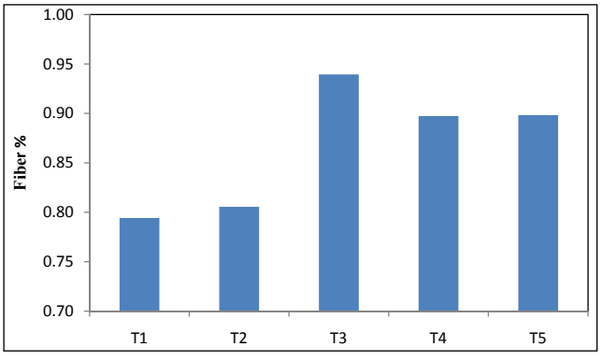

Fig. 4: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on fiber content of multigrain mixes

Ash

The Fig. 5 shows the ash content for multigrain mixes using finger millet malt and moth bean malt. Ash content was in the range of 1.773 to 2.2735 %, it was 1.803, 1.773, 2.273, 1.470, 1.871 % for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest ash content was observed for treatment T_3 and lowest ash content was observed at treatment T_4. The finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the ash content shows gradually increases from T_1-T_3 followed by decreasing trend. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the ash content (%) of multigrain mixes for finger millet malt at $p \leq 0.05$ can be seen from Table 2(e). Rana *et al*. (2015) reported that ash content of multigrain dalia mixes prepared from wheat, gram, oat 2.58%. Itagi and Singh, (2012) reported that ash content of multigrain mixes prepared from Cereals and millets (rice, wheat, ragi, pulses-whole chickpea, whole green gram, puffed bengal gram, defatted soya powder, nuts and oil seeds, almond, cashew nut, sesame, condiments poppy seeds) was 2.2%. Arya and Gaikwad, (2017) reported that ash content in *thalipeeth* prepared from sorghum, wheat, chickpea, black gram flour was 2.66%. Shinde (2017) reported that ash multigrain in premixes prepared from wheat, soya mince, Bengal gram, rice, lentil, green gram was 2.07%.

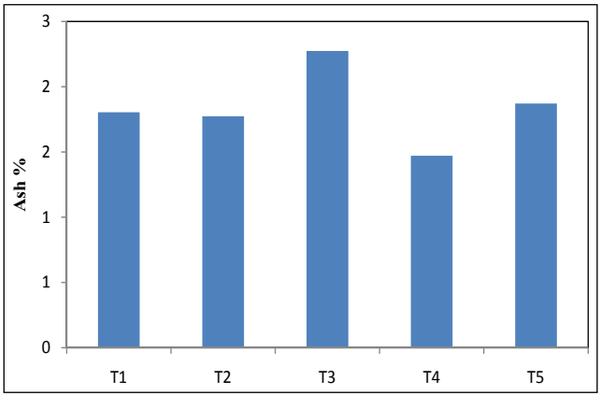

Fig. 5: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on ash content of multigrain mixes

Carbohydrate

The Fig. 6 shows the carbohydrate content for multigrain mixes using finger millet malt and moth bean malt was in the range of 73.93 to 77.95, it was 78.30, 77.33, 73.94, 77.04, 75.82% for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest carbohydrate content was observed for treatment T_1 and lowest carbohydrate content was observed at treatment T_3. The finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the carbohydrate content shows gradually decreases from T_1-T_3 followed by increasing trend. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the carbohydrate content (%) of multigrain mixes for finger millet malt at $p \leq 0.05$ can be seen from Table 2(f). Arya and Gaikwad, (2017) reported that carbohydrate in multigrain mixes prepared from sorghum, wheat, chickpea, black gram flour was 69.43%. Shinde (2017) reported that carbohydrate multigrain in premixes prepared from wheat, soya mince, Bengal gram, rice, lentil, green gram was 69.98%

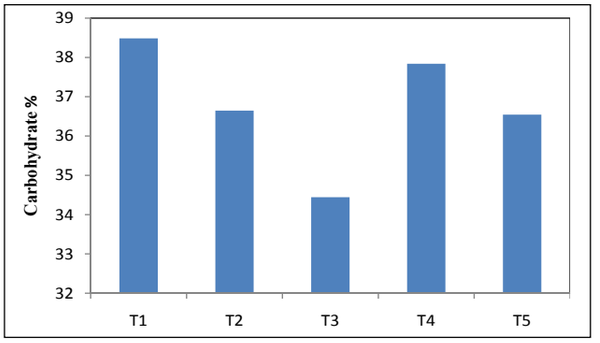

Fig. 6: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on carbohydrate of multigrain mixes

Whiteness index of multigrain mixes

The Fig. 7 shows the whiteness index of multigrain mixes using finger millet malt and moth bean malt. The whiteness index was in the range of 17.74 to 25.66, it was 17.74, 24.37, 24.32, 25.66, 23.79 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest whiteness index was observed for treatment T_4 and lowest whiteness index was observed at treatment T_1. The finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the whiteness index gradually increases.

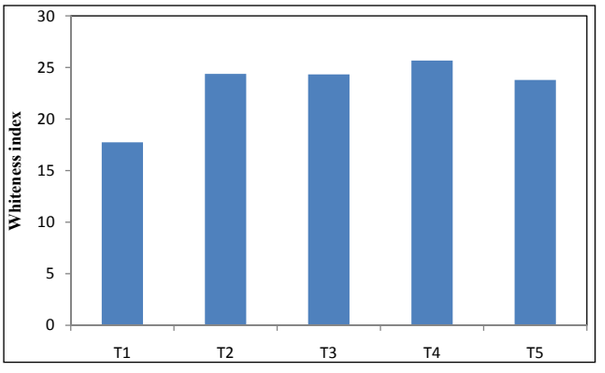

Fig. 7: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on whiteness index content of multigrain mixes

The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the whiteness index of multigrain from multigrain mixes at $p \leq 0.05$ can be seen from Table 2(g). Angioloni and Collar (2011) reported that whiteness index of bread from multigrain mixes from oat, rye, kamut, spelt, rye, buckwheat, wheat flour was 31.05. Kudake *et al*. (2018) reported that whiteness index of noodles prepared from finger millet flour and wheat flour was 34.08.

Calorific value

The Fig. 8 shows the calorific value for multigrain mixes using finger millet malt and moth bean malt. The calorific value was in the range of 374.89 to 376.84 (kcal/100g), it was 376.84, 375.15, 374.89, 375.73, 374.92 for treatments T_1, T_2, T_3, T_4, and T_5 respectively. The highest calorific value was observed for treatment T_1 and lowest calorific value was observed at treatment T_3. The finger millet malt was increased and moth bean malt decreases from treatment T_1 to T_5 the calorific value shows gradually decreasing from T_1-T_3 followed by increasing trend. The effect of treatment combination i.e. T_1, T_2, T_3, T_4, and T_5 was significant effect on the calorific value (kcal/100g) of multigrain mixes for finger millet malt at $p \leq 0.05$ can be seen from Table 2(h). Okpala *et al*. (2013) reported that calorific value of cookies prepared from germinated pigeon pea, fermented sorghum, and cocoyam flour mixes 370.81 (kcal/100g).

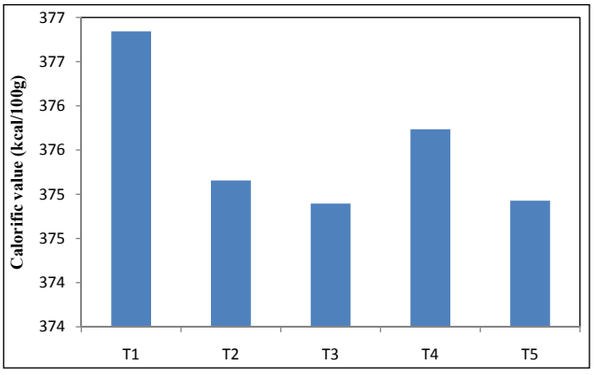

Fig. 8: Effect of various treatments combination (T_1-T_5) of FM malt and MB malt on calorific value of multigrain mixes

Itagi and Singh, (2012) reported that ash content of multigrain mixes prepared from Cereals and millets (rice, wheat, ragi, pulses-whole chickpea, whole green

gram, puffed bengal gram, defatted soya powder, nuts and oil seeds, almond, cashew nut, sesame, condiments poppy seeds) was 1711.5 (kcal/100g). Kumar *et al*.(2015) reported that calorific value of multigrain premixes prepared from chickpea, oats, finger millet, wheat, defatted soya was 379.13 (kcal).

Sensory Analysis

The data obtained for sensory properties viz. colour, taste, and texture of *thalipeeth* prepared from multigrain mixes as per the nine point hedonic scale were obtained from semi-trained panel for treatment T_1 to treatment T_5 are given in Table 4. The average score of *thalipeeth* ranged between 7.1 to 8.7.

Fig. 9 shows the sensory colour score. The sensory colour score was in the range of 7.1 to 8.2. Highest colour score was observed at T3 it was 8.2 and lowest colour score 7.1 was observed at T1. The control sample had 7.4 colour score. Table 4(a) shows ANOVA for the colour of sensory analysis. *Thalipeeth* prepared from multigrain mixes (finger millet malt and moth bean malt) shows significant effect at on colour.

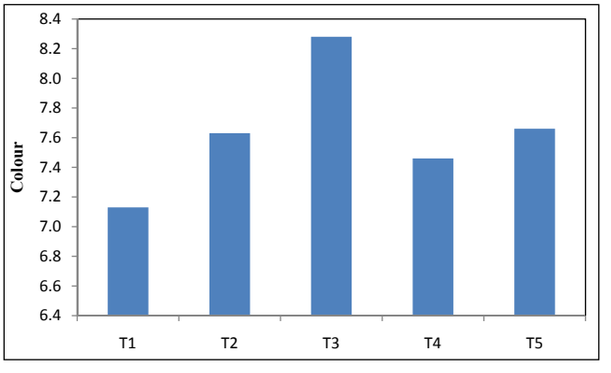

Fig. 9: Sensory colour score of *thalipeeth*

Fig. 10 shows the sensory taste score. The sensory taste score was in the range of 7.4 to 8.78. Highest taste score was observed at T3 it was 8.7 and lowest taste score 7.4 was observed at . The control sample had taste scale of 7.5. Table 4 (b) shows ANOVA for the taste of sensory analysis. *Thalipeeth* prepared from multigrain mixes (finger millet malt and moth bean malt) shows significant effect at on taste.

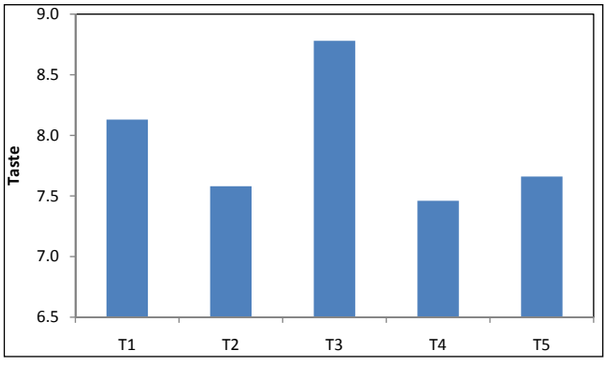

Fig. 10: Sensory colour score of *thalipeeth*

Fig. 11 shows the sensory texture score. The sensory texture score was in the range of 7.3 to 8.4. Highest texture score was observed at T3 it was 8.4 and lowest texture score 7.3 was observed at . The control sample had texture scale of 7.3. Table 4 (c) shows ANOVA for the texture of sensory analysis. *Thalipeeth* prepared from multigrain mixes (finger millet malt and moth bean malt) shows significant effect at on texture.

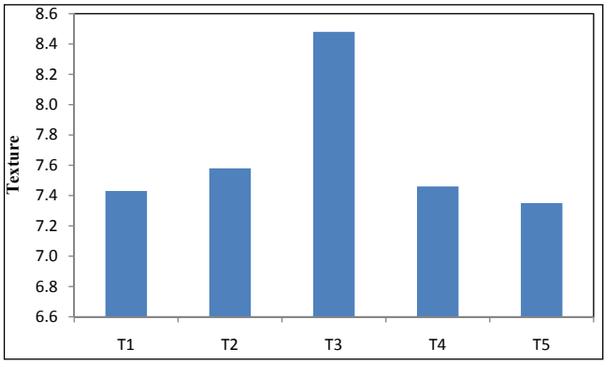

Fig. 11: Sensory colour score of *thalipeeth*

Fig. 12 shows the sensory overall acceptability score. The sensory overall acceptability score was in the range of 7.3±0.5 to 8.4±0.5. Highest overall acceptability score was observed at T3 it was 8.4 and lowest overall acceptability score 7.3 was observed at T_5. The control sample had overall acceptability scale of 8.4. Table 4 (d) shows ANOVA for the overall acceptability of sensory analysis. *Thalipeeth* prepared from multigrain mixes (finger millet malt and moth bean malt) shows significant effect at on overall acceptability.

From the sensory score of the *thalipeeth* develops from multigrain mixes (finger millet malt 26% and moth bean malt 26%) are significant effect at . on colour, taste, texture and overall acceptability was observed. It can be concluded that treatment T3 with incorporation of finger millet malt (26%) and moth bean malt (26%) incorporated *thalipeeth* has the highest score (colour 8.2, taste 8.78 and texture 8.4 and overall acceptability 8.4) resulted the best treatment compared with all other treatments.

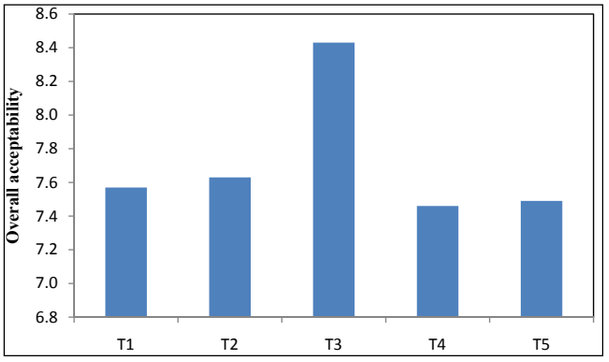

Fig. 12: Sensory overall acceptability score of *thalipeeth*

Corelation between the objective and subjective scores

The best sensory score of the product have been obtained from multigrain mixes at finger millet malt 26% and moth bean malt 26% incorporation in *thalipeeth*, product achieved that the higher colour 8.20, taste 8.78, Texture 8.40 and overall acceptability 8.4, moisture content 5.75 %, protein 14.94 %, fat 2.14%, fibre 0.93%, ash 2.27% and carbohydrate 73.93%, calorific value 374.895 (kcal/100g), whiteness index 24.32.

CONCLUSION

The best quality of multigrain mixes based can be produced with incorporation of finger millet malt 26% and moth bean malt 26%. The moisture content 5.75 %, protein 14.94 %, fat 2.14 %, fibre 0.93%, ash 2.27% and carbohydrate 73.93%, calorific value 374.895 (kcal/100g), whiteness index 24.32. and have heights sensory score higher colour 8.20, taste 8.78, Texture 8.40, overall acceptability 8.4.

Table 3: ANOVA of sensory

Parameter	Sample Code	(a) Colour	(b) Taste	(c) Texture	(d) Overall accetability
T1	A	7.1±0.2	8.1±0.4	7.4±0.4	7.6±0.7
T2	B	7.6±0.2	7.5±0.2	7.5±0.2	7.3±0.5
T3	**C**	**8.2±0.4**	**8.78±0.2**	**8.4±0.6**	**8.4±0.5**
T4	D	7.4±0.4	7.4±0.4	7.4±0.6	7.4±0.5
T5	E	7.6±0.4	7.6±0.4	7.3±0.4	7.5±0.5
Control	F	7.4±05	7.5±0.2	7.3±0.2	7.4±0.5
SE± at P≤0.05		1.5	1.5	1.7	1.5
CD at P≤0.05		4.4	4.6	5.1	4.4

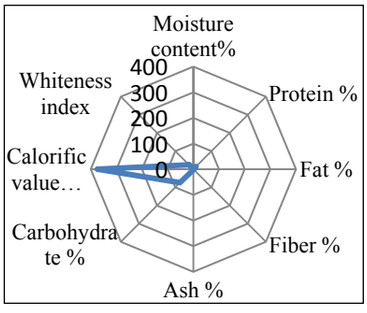

Fig. 13 (a): Quality analysis of multigrain mixes

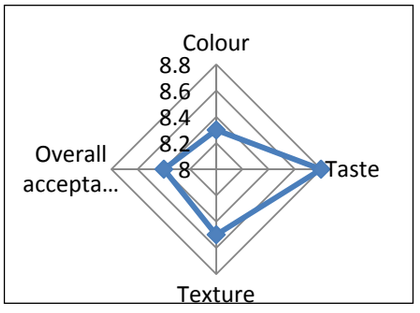

Fig. 13(b): Sensory score of *thalipeeth*

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