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Formulation and quality evaluation of multigrain bhakari premix

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Abstract
The present investigation was undertaken with the objective to study the formulation and quality evaluation of multigrain bhakari premix by using various grains *viz* sorghum, finger millet, amaranth, oats and defatted soy flour. The efforts have been made to formulate the nutritional multigrain bhakari premix with the varying concentration of grains. The different physical properties such as kernel size (mm), 1000 kernel weight (gm), true density (g/ml), bulk density (g/ml), sphericity (%) and porosity (%) were determined. The results of multigrain bhakari premix revealed that the carbohydrate content was decreased from 72.09 to 68.75g/100g and the protein content was increased from 10.62 to 12.4 g/100g as the concentration of different grains flour increased and sorghum flour decreased. Further, the minerals and vitamins content were also found to be increased. However, the sample MPB_3 found highest overall acceptability (7.65) amongst the other sample Finally, it was concluded that good quality multigrain bhakari premix can be prepared by using 30% sorghum, 23.33% finger millet, 23.33% amaranth and 23.33% oats flour with good overall acceptability and nutritional profile.

Keywords: Sorghum, multigrain bhakari premix, defatted soy flour, grains etc.

1. Introduction
The term malnutrition means both undernutrition and over nutrition. It is important factor in child mortality (Mohajan, 2014) [1]. Malnutrition caused due to inadequate intake of nutrients in children, the elders and lactating mother (Ragaee *et al*., 2006) [2]. Development of nutritionally rich multi-flour may decrease the level of malnutrition. Cereals possess good amount of protein and it is vehicle for delivering proteins to at risk populations due to its world wide spread consumption, stability and versatility (Bulusu *et al*., 2007) [3]. The concept of cereal-legume complementation by blending cereal with legume flour can be applied to increase protein content (FAO/WHO, 1994) [4]. The changing lifestyle of people with changing dietary patterns can lead to increasing precedence of disease like type 2 diabetes, coronary heart disease, cancer, periodontal disease and obesity. Wholesome foods can help to prevent and treat the problems. Now, consumers are aware and consume food for not only as source for satiety but also means of disease prevention and control (Siro *et al*., 2008) [5].
Finger millet possess various health benefits and it's attributed to its polyphenol content (Chethan and Malleshi, 2007) [6]. The protein content in finger millet is better balanced, it contains high amount of lysine, threonine and valine than other millets (Glew *et al*., 2008) [7]. Sorghum possess nutraceutical properties such as antioxidant phenolics and cholesterol-lowering waxes. There are many products prepared from sorghum such as cakes, cookies, pasta, a parboiled rice like products and snack products (Taylor *et al*., 2006) [8]. Amaranth grain has good nutritional profile and amaranth grain possess good amount of lysine and tryptophan (Mlakar *et al*., 2010) [9]. Oats contains high amount of nutrients like protein with essential amino acids and other minor nutrients like dietary fibre, antioxidants, vitamins, phenolic compounds, minerals, and essential unsaturated fatty acids (Singh *et al*., 2013; Biel *et al*., 2009) [10, 11].
In most of the regions of India bhakari is consumed as a staple food. In view of the importance of grains present investigation was undertaken to develop the multigrain premix from different grains like finger millet flour, amaranth flour, sorghum flour and oats flour with respect to increase nutritional quality, sensory attributes, consumer acceptability and commercial exploration of the product.

2. Materials and Method
The present investigation has been carried out at MIT College of Food Technology, MITADT University, Pune.

The required raw material such as sorghum, finger millet, amaranth and oats were procured from local market.

2.1 Physical characteristics of raw materials: The grains were subjected to physical characteristics *viz.* 1000 kernel weight, bulk density, true density, porosity, angle of repose and geometric mean diameter according to the standard procedure given by Sunil *et al.*, (2016) [12].

2.2 Chemical characteristics of raw materials: The different chemical characteristics like moisture, carbohydrates, fats, protein, vitamins and minerals of grains and finished premix were determined as per the method given by the Ranganna (2011) [13].

2.3 Organoleptic evaluation of developed product: Sensory evaluation of finished product was evaluated by 10 semi-trained panel members by using 9-point hedonic scale (Meilgard *et al*., 1999) [14].

2.4 Formulation of multigrain premix: The multigrain premix was prepared by blending appropriate amount of sorghum flour, amaranth flour, finger millet flour and oats flour. Different levels of grains flours were taken to make product nutritionally enriched and presented in table 1.

Table 1: Formulation of multigrain premix

Formulation of multigrain premix (g/100)							
Sr. No.	**Flour**	**MP_0**	**MP_1**	**MP_2**	**MP_3**	**MP_4**	**MP_5**
1	Sorghum	100	50	40	30	25	20
2	Finger millet	-	16.66	20	23.33	25	26.66
3	Amaranth	-	16.66	20	23.33	25	26.66
4	Oats	-	16.66	20	23.33	25	26.66

Where, MP_0= Control Sample, MP= Multigrain Premix

2.5 Preparation of multigrain bhakari Premix: The multigrain bhakari premixes were prepared with standardised proportion of multigrains. The control sample was formulated only by using the sorghum flour. The processing methodology or steps are representing in figure 1.

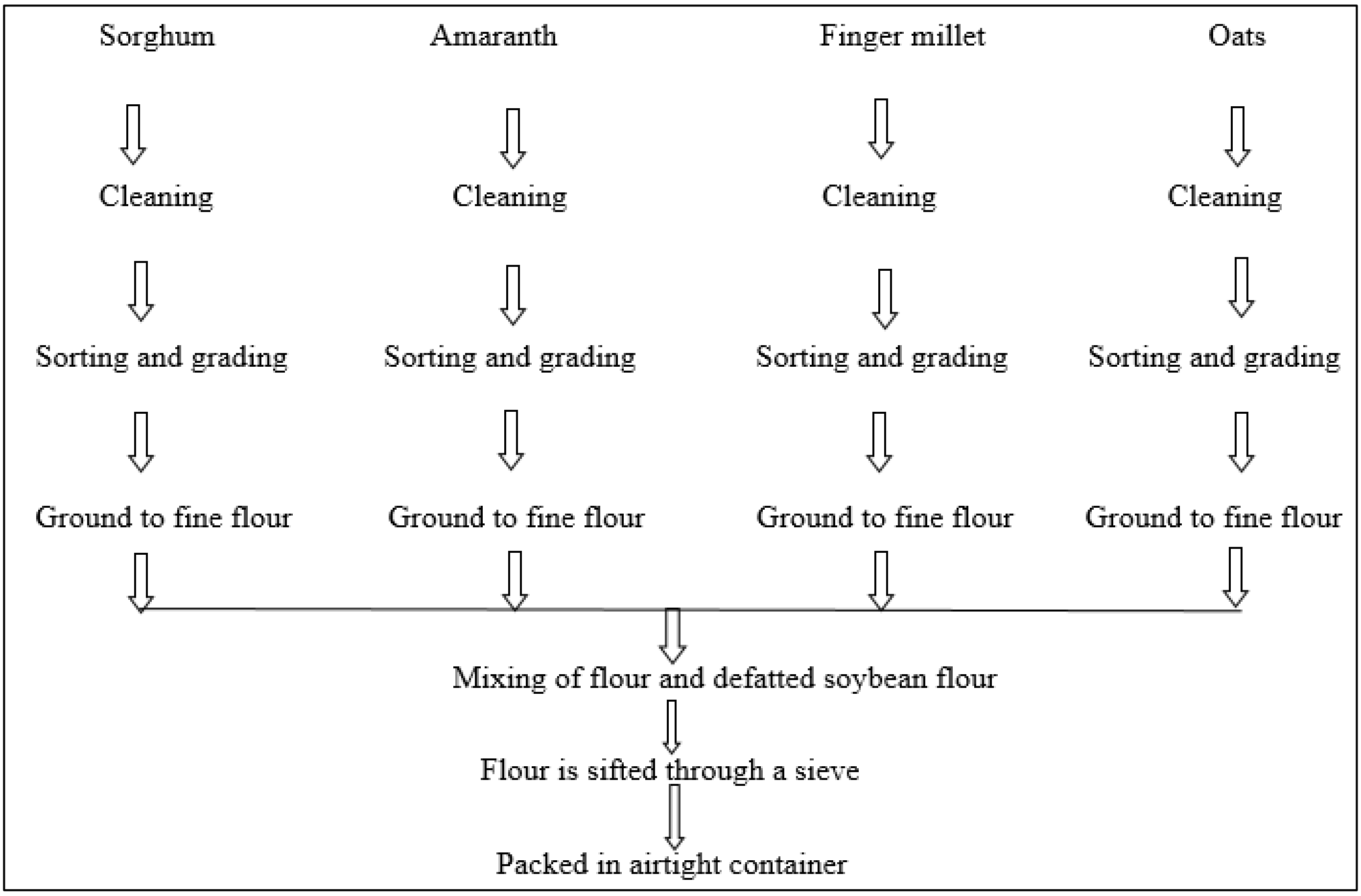

Fig 1: Preparation of multigrain bhakari premix

2.6 Preparation of Bhakari by using multigrain premix
The bhakari were prepared by using the multigrain premix as given in the Table 1. The multigrain bhakari were prepared as per the method given by Chavan *et al*., 2018 [15] with slight modification.

3. Results and Discussions
3.1 Physicochemical properties of different grains: The data depicted in table 2 revealed that the 1000 kernel weight was found highest in soybean (120g) followed by amaranth (48.32g) and lowest was recorded in finger millet (15.13g) due to its size variation large deviation was recorded in 1000 kernel weight. 1000 kernel weight is important factor to evaluate grain yield. The size of sorghum, finger millet, amaranth, oats and soybean were found to be 3.527, 1.414, 0.940, 1.026 and 5.67 respectively. The bulk density and true density was found highest in oats (0.980 g/ml) and amaranth (1.33 g/ml) respectively. The true and bulk density plays a significant role in drying, design of silos and storage bins, separation of undesirable materials, seed purity determination and grading (Mohsenin, 1986) [16].

Sphericity is used to describe the shape of a grain. The resistance of bulk grain to air flow is the function of porosity and kernel size. The percent sphericity of oats (36.57) was found highest followed by sorghum (20.59), amaranth (1.24), finger millet (0.96) and soybean (0.836). The percent porosity of sorghum, finger millet, amaranth, oats and soybean were noted as 31.53, 35.04, 37.59, 23.43 and 38 respectively. The angle of repose found highest in oats (42.53º), followed by soybean (36.54º). The results recorded for the physical properties of grains are in line with the data reported by the Masane *et al.*, 2016 [17] and Hamdani *et al*., 2014 [18].

The findings in table 2 showed that the percent moisture content of sorghum, finger millet, amaranth, oats and defatted soy flour was noted as 11.22%, 11.89%, 12.01%, 8.59% and 11.65% respectively. The carbohydrate content was found highest in finger millet (73.6g) followed by sorghum (72.09g) whether, lowest carbohydrates content was recorded in defatted soy flour (31.92g).

The protein content was found highest in defatted soy flour i.e. 51.46g and lowest in finer millet i.e. 9.1g. However, fat content was lowest in sorghum, finger millet, amaranth, oats and defatted soy flour was found to be 3.46 g/100g, 2.3 g/100g, 7 g/100g, 6.9 g/100g and 0.43g/100g respectively. The theoretical energy content was calculated and the results obtained showed that the oats (394.9 kcal/100g) provide the highest calories due to the higher concentration of fat and carbohydrate as compared to the other grains flour. The chemical properties of sorghum flour, oats flour, amaranth and defatted soy flour are comparable with the results reported by the Itagi and Sreeramaiah (2017) [19]; Youssef *et al*., (2016) [20]; Mburu *et al*., (2012) [21] and Mustakas (1971) [22] respectively.

Table 2: Physicochemical properties of different grains

Sr. No.	Parameters	Sorghum	Finger millet	Amaranth	Oats	Soybean
Physical properties						
1	1000 kernel weight (g)	32.50	15.13	48.32	36.16	120.0
2	Geometric mean diameter (mm)	3.527	1.414	1.414	1.026	5.67
3	Bulk density (g/ml)	0.769	0.769	0.833	0.980	0.625
4	True density (g/ml)	1.11	1.17	1.33	1.28	1.00
5	Sphericity (%)	20.59	0.96	1.24	36.57	0.836
6	Porosity (%)	31.53	35.04	37.59	23.43	38.00
7	Angle of repose(º)	33.02	30.02	26.58	42.43	36.54
Chemical properties						
8	Moisture (%)	11.22	11.89	12.01	8.59	11.65
9	Carbohydrate (g)	72.09	73.6	65	66.3	31.92
10	Protein (g)	10.62	9.1	14	16.9	51.46
11	Fat (g)	3.46	2.3	7	6.9	0.43
12	Energy (Kcal)	361.98	351.5	379	394.9	337.39

*Each value is an average of three determinations

3.2 Minerals and Vitamins content in raw material: Minerals content determines amount of specific inorganic components present in food. Table 3 revealed that calcium content in sorghum, finger millet, amaranth, oats and defatted soy flour was found 13 mg/100g, 350 mg/100g, 159 mg/100g, 54 mg/100g and 241 mg/100g respectively. Among the selected grains highest calcium content was recorded in finger millet followed by amaranth and defatted soy flour. The iron content was found highest in defatted soy flour i.e. 9.24 mg/100g whether, lowest in sorghum i.e. 3.36 mg/100g. Iron is required for proper function of haemoglobin and also important in other processes in the body. Magnesium plays an important role proper function of kidney, heart and muscles. The magnesium content in sorghum, finger millet, amaranth, oats and defatted soy flour were found 165 mg/100g, 168.5 mg/100g, 248 mg/100g, 177 mg/100g and 290 mg/100g respectively.

Further, the determined manganese content was recorded highest in finger millet (24.09 mg/100g) as compared to the other samples. Manganese is considered as essential nutrient which helps in physiologic processes. The phosphorus content in sorghum, finger millet, amaranth, oats and defatted soy flour was determined as 289 mg/100g, 238 mg/100g, 557 mg/100g, 523 mg/100g and 674 mg/100g respectively. Phosphorous helps to growth and repair body cells and tissue.

The data presented in table 3 showed that the potassium content was higher in defatted soy flour (2384 mg/100g) and lower in sorghum (363 mg/100g). Potassium is important mineral which helps to regulate fluid balance, muscle contraction and nerve signals. The zinc content of sorghum, finger millet, amaranth, oats and defatted soy flour were found 1.67 mg/100g, 2.81 mg/100g, 2.9 mg/100g, 3.97 mg/100g and 2.46 mg/100g respectively. Zinc is required for DNA synthesis, immune function, metabolism and growth and it may reduce inflammation and your risk of some age-related diseases. The minerals content of sorghum flour, finger millet flour, amaranth flour and oats flour shows similar results reported by Itagi and Sreeramaiah (2017) [19]; Kishorgoliya *et al*., (2018) [23] and Netravati *et al*., (2018) [24]; Youssef *et al.*, (2016) [20] respectively.

The vitamin B_1 content in grains flour like sorghum, finger millet, amaranth, oats and defatted soy flour were found to be 0.33 mg/100g, 0.43 mg/100g, 0.1 mg/100g, 0.76 mg/100g and 0.69 mg/100g respectively. Thiamine perform important role in muscle contraction and conduction of nerve signals and also help body cells change the carbohydrate into energy (Lonsdale, 2006) [25].

Table 3: Minerals and vitamins content in raw material

Sr. No.	Parameters (mg/100g)	Sorghum	Finger millet	Amaranth	Oats	Soybean
Minerals content						
1	Calcium	13	350	159	54	241
2	Iron	3.36	3.9	7.6	4.72	9.24
3	Magnesium	165	168.4	248	177	290
4	Manganese	1.605	24.09	3.4	4.916	3.018
5	Phosphorus	289	238	557	523	674
6	Potassium	363	408	508	429	2384
7	Zinc	1.67	2.81	2.9	3.97	2.46
Vitamins Content						
8	Thiamine	0.33	0.43	0.1	0.76	0.69
9	Riboflavin	0.09	0.18	0.2	0.13	0.25
10	Niacin	3.68	1.01	0.9	0.96	2.61
11	Pantothenic acid	0.36	-	1.5	1.34	1.99

*Each value is an average of three determinations

The riboflavin content was found highest in defatted soy flour (0.25 mg/100g) followed by finger millet (0.18 mg/100g) and lowest was recorded in sorghum 0.09mg/100g. The niacin and Pantothenic acid were found highest in sorghum and soybean flour as 3.68 and 1.99 mg/100g respectively. Riboflavin is important vitamin helps in growth whereas niacin is required for digestive system, skin and nervous system functioning.

Pantothenic acid helps to make red blood cells and also helps to convert food into energy. The vitamin B_5 content in sorghum, amaranth, oats and defatted soy flour was found 0.36 mg/100g, 1.5 mg/100g, 1.34mg/100g and 1.99 mg/100g whereas. The results presented in table 4 are close with the data presented by the Dayakar *et al.*, (2017) [26].

3.3 Proximate analysis of multigrain bhakari premix: The different chemical properties such as moisture, carbohydrates, proteins, fat and energy value of the prepared multigrain premix were determined. The different grains are rich in different nutrients which ultimately contribute to a nutritional value of prepared premix. The results pertaining the chemical analysis are depicted in Table 4.

Table 4: Proximate analysis of multigrain bhakari premix

Proximate analysis of multigrain bhakari premix									
Sr. No.	**Parameters (g/100g)**	**Control**	**MBP_1**	**MBP_2**	**MBP_3**	**MBP_4**	**MBP_5**	**SE**	**CD at 5%**
1	Moisture (%)	11.5	11.7	11.6	11.7	11.4	11.6	0.0638	0.1921
2	Carbohydrate	72.09	69.99	69.61	69.17	68.99	68.75	0.0062	0.0185
3	Protein	10.62	11.73	11.96	12.17	12.29	12.4	0.017z2	0.0519
4	Fat	3.46	4.24	4.42	4.56	4.66	4.74	0.0043	0.013
5	Energy	361.98	365.04	366.06	366.4	367.06	367.26	0.0109	0.0328

*Each value is an average of three determinations

The data recorded in the table 4 indicates that the multigrain premix showed the noticeable difference in the protein and carbohydrate content. The negligible difference was recorded in the moisture content among all the samples. The highest carbohydrate content was recorded in control flour (72.09 g/100g) while lowest in MBP_5 (68.75 g/100g). The carbohydrate content was found to be decreased as the concentration of finger millet, amaranth and oats flour increased. However, it could be observed that the protein content was increased from 10.62 to 12.4 g/100g as the sorghum flour level was reduced with gradual increase in the concentration of other grains flour. Highest protein content was observed in sample MBP_5 (12.4 g/100g).

The fat content in multigrain premix sample was recorded in the range from 3.46 to 4.74 g/100g. The fat content in MBP_1, MBP_2, MBP_3, MBP_4 and MBP_5 samples was found to be 3.46, 4.24, 4.42, 4.66 and 4.74g/100g respectively. Energy content was found lowest in control sample (361.98 kcal/100g) whereas as highest in MBP_5 (367.26 kcal/100g).

3.4 Minerals and vitamins content of multigrain bhakari premix: The data presented in table 5 revealed that the drastic calcium content was found to be increases as compared to control flour due to increase in the concentration of finger millet, amaranth and defatted soy flour. The calcium content of control, MBP_1, MBP_2, MBP_3, MBP_4 and MBP_5 was found 13, 100.28, 117.8, 135.23, 144 and 202.54 mg/100g respectively. The iron content among all the premix samples was recorded in between 3.46 to 5.68 mg/100g. The magnesium content was found lowest in control flour i.e. 165 mg/100g whereas, highest in MBP_5 191.18 mg/100g.

The manganese, Phosphorus, Potassium and zinc content was found to be increased as the level of grains flour increased from control to MBP_5. The manganese content was recorded in the range 1.605 mg/100g to 2.53 mg/100g. The phosphorus content was found lowest in control flour i.e. 289 mg/100g and highest in MBP_5 i.e. 345.72 mg/100g. The potassium content in control, MBP_1, MBP_2, MBP_3, MBP_4 and MBP_5 were found to be 363, 405.57, 414.2, 422.67 and 452.37 mg/100g respectively. The zinc content was found highest in MBP_5 (2.16 mg/100g) whereas found lowest in control (1.67 mg/100g).

Table 5: Mineral and vitamins content of multigrain bhakari premix

Mineral and vitamins content of multigrain bhakari premix									
Sr. No.	**Parameter (mg/100g)**	**Control**	**MBP_1**	**MBP_2**	**MBP_3**	**MBP_4**	**MBP_5**	**SE**	**CD at 5%**
1	Calcium	13.00	100.28	117.8	135.23	144.00	202.54	0.3341	1.005
2	Iron	3.46	5.68	4.58	4.79	4.89	4.99	0.007	0.021
3	Magnesium	165.00	181.34	184.68	187.92	189.6	191.18	0.210	0.633
4	Manganese	1.60	2.19	2.61	2.42	2.48	2.53	0.024	0.072
5	Phosphorus	289.00	324.42	331.60	338.61	342.25	345.72	0.210	0.632
6	Potassium	363.00	405.57	414.20	422.67	427.00	452.37	0.265	0.799
7	Zinc	1.67	1.97	2.04	2.10	2.13	2.16	0.018	0.055
8	Thiamine	0.332	0.378	0.388	0.397	0.404	0.408	0.0006	0.0017
9	Riboflavin	0.096	0.128	0.138	0.144	0.149	0.152	0.0003	0.0009
10	Niacin	3.68	2.33	2.06	1.79	1.66	1.49	0.0092	0.0278
11	Pantothenic acid	0.36	0.65	0.71	0.77	0.80	0.82	0.0098	0.0295

*Each value is an average of three determinations

The estimated results recorded in table 5 showed that thiamine content was found in the ranges from 0.332 to 0.408 mg/100g among all the premix samples. There was significant difference in riboflavin content was found i.e. 0.096, 0.128, 0.138, 0.144, 0.149 and 0.152 mg/100g in control, MBP_1, MBP_2, MBP_3, MBP_4 and MBP_5 respectively. The niacin content in multigrain bhakari premix decreases as increase the concentration of multiflours as sorghum flour found rich in niacin. The niacin concentration in control, MBP_1, MBP_2, MBP_3, MBP_4 and MBP_5 was found 3.68, 2.33, 2.06, 1.79, 1.66 and 1.49 mg/100g respectively. The Pantothenic acid content was found lowest in control (0.36 mg/100g) while highest in MBP_5 (0.82 mg/100g).

3.5 Organoleptic evaluation of multigrain bhakari prepared by using multigrain premix: The multigrain bhakari were prepared as per the formulation designed in table 1 from the multigrain premix. The prepared bhakari were subjected for sensory evaluation by using 9-point hedonic scale from the 10-semi trained panellist. The different sensory attributes like color, appearance, flavour, taste, texture and overall acceptability were evaluated. The sensory responses noted by the sensory panel member are tabulated in table 6 and figure 2.

Table 6: Sensory evaluation of multigrain bhakari prepared by using multigrain premix

Sensory evaluation of multigrain bhakari									
Sr. No.	**Attributes**	**MBP_0**	**MBP_1**	**MBP_2**	**MBP_3**	**MBP_4**	**MBP_5**	**SE**	**CD at 5%**
1	Color and appearance	7.9	7.7	7.5	7.5	7.0	6.5	0.0667	0.2007
2	Flavour	7.5	8.0	8.0	8.0	7.6	7.2	0.033	0.100
3	Taste	6.9	7.2	7.2	7.8	7.6	7.4	0.081	0.245
4	Texture	7.3	7.1	7.3	7.3	7.0	6.5	0.0397	0.119
5	Overall acceptability	7.4	7.5	7.5	7.65	7.3	6.9	0.0615	0.185

*Each value is an average of ten determinations

It is visualized from Table 6, that the multigrain bhakari shown no major differences with regard to appearance and colour sensory score up to the sample MBP_3 thereafter the appearance and color was found to be decreased. The decrease in color and appearance may be due to the color of the multigrains. The lowest color and appearance score was recorded by the panelist for the sample MBP_5 (6.5). Mean score values for flavour of multigrain bhakari samples indicates that the flavour character was more acceptable up to the MPB_3 (8.0) as compared with all other samples. The increase in the concentration of the multigrains wide differences with regard to texture sensory score the sample MBP_2 and MBP_3 got best score for the texture i.e. 7.3 compared with the other samples.

The organoleptic evaluation showed that best taste was observed in case of sample MBP_3 (7.8) as compared to the control sample. Increase in multigrain concentration taste was found to be increased up to certain level and then decreases. From the investigation the sample MBP_3 found highest overall acceptability (7.65) amongst the other sample. So, sample MBP_3 was selected for further fortification by using defatted soy flour.

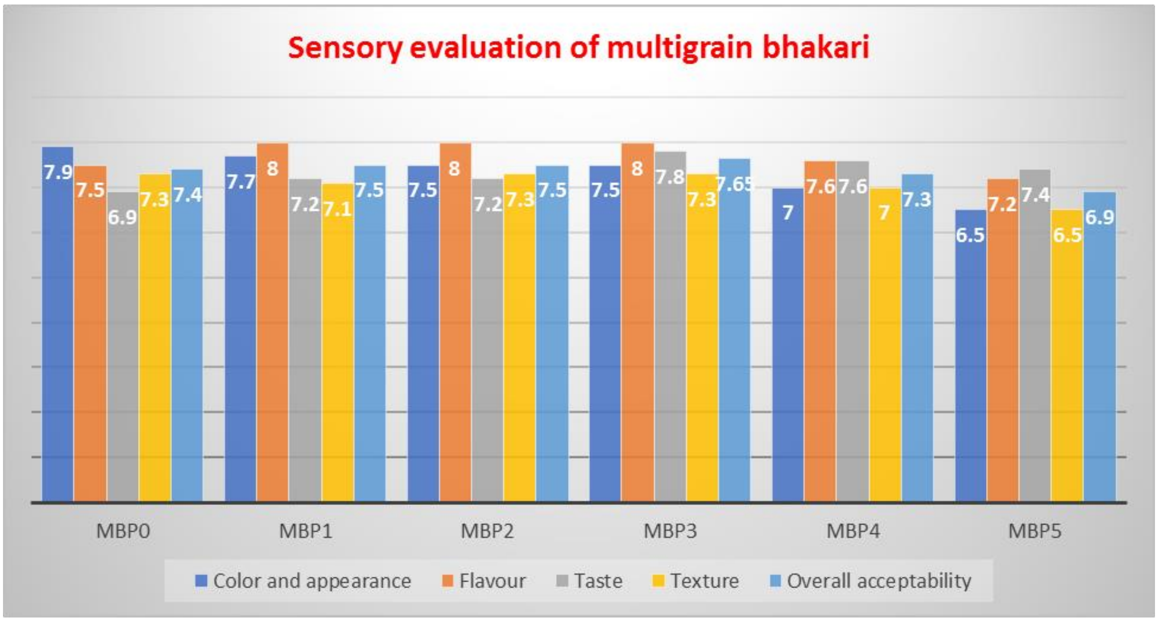

Fig 2: Graphical representation Sensory evaluation of multigrain bhakari

4. Conclusion

In light of the facts and figures of the present investigation it can be concluded that the good quality multigrain bhakari premix can be prepared by using sorghum, finger millet, amaranth and oats with good overall acceptability and nutritional profile.

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