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Deepika Baranwal
Assistant Professor, Department of Home Science, Arya Mahila PG College, BHU, Varanasi, Uttar Pradesh, India

Arti Sankhla
Professor, College of Home-Science, MPUAT, Udaipur, Rajasthan, India

Correspondence
Deepika Baranwal
Assistant Professor, Department of Home Science, Arya Mahila PG College, BHU, Varanasi, Uttar Pradesh, India

Physical and functional properties of malted composite flour for biscuit production

Deepika Baranwal and Arti Sankhla

Abstract
In the present investigation, during the process of standardization of flour, biscuit prepared in four levels of Malted Coarse Grain (barley, sorghum, pearl millet, 1:1:1) blend (10-40%) with wheat (50-80%) and defatted soy flour (10%). After sensory evaluation, all the four variations of flours were liked moderately by panel members. Though, the all four treatments were not significantly different from each other, the highest ratio of MCG blend (40%) in composite flour was selected to meet the goal of value addition for further physical and functional properties evaluation. The observations in case of physical properties of malted composite flour i.e. particle size, bulk density, crude gluten, wet gluten and sedimentation volume were found to be 170.38 micron, 0.56 g/ml, 8.60 %, 20.66 % and 23.66 ml respectively. Functional properties of malted composite flour were reported to be 1.45 % Water Absorption Capacity, 1.72 % Oil Absorption Capacity, 16 % Least Gelation Concentration, 33% Foaming Capacity, 62 % Foaming Solubility, 12.46 % Swelling Power, 12.83 % Solubility, 67.33 % dispersibility, and 1.86 mg/100g maltose value. The physical and functional characteristics of the developed malted composite flour were found as per the desired standards required for bakery products.

Keywords: biscuits, flour, coarse grains, maltose value, composite flour etc.

Introduction

Among ready-to-eat snacks, biscuits possess several attractive features including wider consumption base among all age groups in many countries, relatively long shelf-life, more convenience and good eating quality (Akubor, 2003; Hooda and Jood, 2004, Hussien *et al*., 2006) [4, 27, 29]. Long shelf-life of biscuits makes large scale production and distribution possible. Good eating quality makes biscuits attractive for protein fortification and other nutritional improvements. Development of fortified biscuits or other composite flour bakery products is the latest trend in bakery industry. The growing interest in these types of bakery products is due to their better nutritional properties and possibility of their use in feeding programs and in catastrophic situations such as starvation or earthquakes (Pratima and Yadava, 2000) [48]. The term 'coarse cereals' covers all cereals except rice and wheat. The economically important cereals cultivated in India include jowar (sorghum), bajra (pearl millet), barley etc. The millet protein has a well-balanced amino acids profile and is a good source of methionine, cystein and lysine. These essential amino acids benefit those who depend on plant food for their nourishment. Barley is a coarse cereal which provides essential vitamins (including those of the B-group) and minerals (especially P, K, Ca, Mg, Se) and it is characterized by a high content of antioxidant compounds (e.g. tocopherols and tocotrienols) and mixed-linked (1/3), (1/4) β-D-glucans (Newman and Newman, 1991) [42]. Several studies have demonstrated that diets high in β-glucans improve diabetes control (Bornet *et al*., 1987) [14], promote growth of probiotic and intestinal bacteria (Crittenden *et al*., 2002) [18], reduce elevated cholesterol (Keenan *et al*., 2007) [32], postprandial blood glucose levels (Cavallero *et al*., 2002) [16] and the risk of colorectal cancer (Hill, 1997) [26] as well as coronary heart disease (FDA HHS, 2008) [24]. The importance of coarse cereals in direct human consumption is declining even though they possess good nutritive value. The demand for coarse grains has to be raised by developing various food products which would be more acceptable by blending the flour of these coarse grains with other grains which are commonly used by the people. Also the coarse grain crops could be very important for ensuring food security. Therefore, greater attention needs to be paid urgently to their production, marketing and utilization. Although millets and cereals are very nutrient rich and easily available but its utilization is limited due to the presence of various anti-nutrients, poor digestibility of proteins and carbohydrates and low palatability However, various processing technologies are able to affect positively the physicochemical composition of food grains in order to improve their nutritional value. Such primary processing technologies include malting. So in this context and millets is beneficial method to overcome this problem in the proposed investigation. Cereal, millets and legumes are used as an inexpensive source of calories. A sorghum+pearl millet+barley+wheat+defatted soy flour blend could become a functional ingredient as well as a vegetable protein source. Such extended use of the blends would depend on the knowledge of their functional properties. However, the only conclusive test for the functionality of malted composite flour is to use it as an ingredient for the preparation of a finished product. Therefore, the objectives of this work were to determine the physical and functional properties of malted composite flour.

Materials and Methods

Procurement of raw materials

Commercially released varieties and traditional cultivars of the selected cereals and millets (wheat-GW366, barley-RD2715, sorghum-CSV 23, pearl millet-RHB 173) and defatted soy flour were procured from different agriculture research stations and processing unit of Udaipur, Jaipur and Gujrat. All the samples were collected in single lot, cleaned and stored in closed bins until used for the study.

Preparation of malted composite flour

Simple home level standardized processing techniques viz. steeping, germination, drying and milling was used for preparation of malted composite flour. After cleaning of the four grains (wheat, barley, sorghum and pearl millet), it was malted i.e. steeping for 12 hrs, germinating for 48 hrs and tray drying at 50°C till the grains were become ready for milling. Then it was sieved for obtaining the equal particle size. The multigrain flour blend was prepared by mixing equal proportion of malted flour of barley, pearl millet and sorghum. The prepared multigrain flour blend was mixed with malted whole wheat flour by replacing at a level of 0% (Control), 10%, 20%, 30% and 40% and keeping the level of defatted soy flour at 10% in all combinations. The ratio of wheat flour in the composite flour was kept ≥50%.

Standardization of malted composite flour

For the purpose of standardization of malted composite flour, different ratios of flour were used for the biscuit preparation. After sensory evaluation on 9 point hedonic scale by trained panel members, best acceptable ratio was selected for the assessment of various physical and functional properties of the selected ratio of malted composite flour.

Determination of the physical and functional properties

Physical properties of flour viz. particle size by the method of Sathe (1999) [49], bulk density by Wang and Kinsella (1976) [53], wet gluten and crude gluten by BIS (1984) [13], SDS-sedimentation volume by Misra *et al*. (1998) [57] and functional tests such as water and oil absorption capacity by the method of Sathe *et al*. (1982) [50], swelling power and solubility by Schoch (1964) [51], foaming capacity and stability by Narayana and Narasinga Rao (1982) [40], dispersibility by (Kulkarni *et al.* 1991) [36], and maltose test by Sathe (1999) [49]. In the present investigation all these physical and functional properties of wheat flour (control), malted composite flour and malted coarse grain blend were analyzed.

Statistical analysis

Data obtained from the organoleptic evaluation, physical and functional properties were subjected to analysis of variance techniques (one way classification) and critical difference was calculated to calculate the significant difference between treatments.

Result and Discussion

Organoleptic evaluation of malted composite flour biscuits

During the process of standardization of flour, biscuit prepared in four levels of MCG blend (10-40%) with wheat (50-80%) and defatted soy flour (10%). It was observed that the color of experimental biscuits was darker as comparison to control (100% refined wheat flour). Darkening of biscuits is attributed to sugar caramelization and the maillard reactions between sugars and amino acids (Alobo, 2001; Abd El-Hady, 2012) [8, 1] in the experimental biscuits due to high protein content (15.79%) in comparison to control (12.06%). These results agree favourably with the results of Barnwal *et al*. (2013) [10]. Present study reported that the overall acceptability of control sample was significantly higher from the experimental sample and it was liked very much whereas any significant difference was not found within the treatments and it was moderately liked by the panel members. Though, the all four treatments were not significantly different from each other, the highest ratio of MCG blend (40%) in composite flour was selected to meet the goal of value addition for further physical and functional properties evaluation.

Physical and functional properties of malted composite flour

Particle size

Particle size distribution of flour indicates friability of wheat endosperm under conditions of milling. A fine powder tends to form more lumps and takes more time and energy to make a good dispersion. Very large particles make the dispersion grittier. Table 1. Represents the particle size of wheat flour (153µ) and malted composite flour (170.30µ). Analysis of variance (ANOVA) showed that the particle size of wheat flour was significantly lower (P≥0.05) than malted composite flour. As per the Codex standard (1985) [17] the maximum size of particles of wheat flour should be 212 micron and results of the present study regarding the particle size of various flours were found to be below this level. So it can be deduced that the all type of flours developed in the present study can be used for chapati making and various bakery products. The present findings are consistent with that of study of Guria (2006) [25] who analyzed the particle size of three varieties of maize (Saktiman-1, S.A.Tall and DMH-2) and reported that the maximum particles of maize flour were in the range between 150µ -180µ. In another study, Krishnan *et al*. (2012) [35] prepared the native, malted, popped and decorticated finger millet flour of less than 250µ particle size. The variations in various studies may be attributed to the grain components, grain structure, pericarp thickness, and varietal differences or due to processing techniques employed (Kikafunda *et al.* 1997; Housson and Ayernor, 2002; Wang *et al.*, 2005, Guria, 2006) [34, 28, 54, 25].

Table 1: Physical Properties of Flours

S. No	Treatments	Particle size (µ)	Bulk density (g/ml)	Crude gluten (dry wt. basis) (%)	Wet gluten (%)	Sedimentation value (ml)
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
1.	WF	153.00±2.64	0.77±0.05	10.89±0.17	29.83±1.44	33.00±1.73
2.	MCF	170.38±0.53	0.56±0.01	8.60±0.52	20.66±3.78	23.66±1.15
3.	MCG	180.33±0.57	0.63±0.05	0.86±0.35	1.33±0.28	16.00±2.00
	CD5%	3.18	0.09	0.76	4.68	3.32
	CD1%	4.82	0.13	1.15	7.09	5.04
	CV	0.95	6.96	5.61	13.57	6.88

Where, Control= 100% refined wheat flour, T1= 1:8:1, T2=2:3:1, T3=3:6:1, T4=4:5:1 of MCG: MWF: DSF

Bulk Density

Bulk density is a measure of heaviness of flour (Oladele and Aina, 2007) [44]. Bulk density gives an indication of the relative volume of packaging material required. The density of processed products dictates the characteristics of its container or package. Product density influences the amount and strength of packaging material, texture or mouth feel. The higher bulk density is desirable for greater ease of dispersibility of flours and is a good physical attribute when determining the mixing quality of a particulate matter. In contrast, however, low bulk density would be an advantage in the formulation of complementary foods (Ugwu and Ukpabi., 2002; Basman *et al*. 2003, Falola *et al*. 2011) [52, 11, 23]. In the present study, the bulk density of wheat flour was analyzed as 0.77 ±0.05 g/ml, which was significantly higher from that of malted composite flour (0.57 ±0.01 g/ml), Table 2. Malted composite flour had comparatively much lower bulk density due to addition of soy flour. This statement was supported by Adetuyi *et al*. (2009) [3]. They reported that the bulk density of the flour from both malted (Mm) and unmalted maize (Umm) decreased after it had been blended with soybean flour Umm from 0.77 to 0.66 g/m^3 while Mm from 0.83 to 0.81 g/m3. This result agreed also with the finding of Akubor and Obiegbuna (1999) [7]. They reported that the bulk density of flour from malted maize and soybeans blend reduced significantly. Similar results were reported by Akubor (2003) [4] who compared the bulk density of wheat flour with cowpea-plantain flour blend. The author observed that this physical parameter for wheat flour was 0.71g/cm^3 and cowpea-plantain flour blend was 0.63 g/cm^3 and both flours could be produced acceptable biscuits. Flour blends with similar bulk densities as the developed flour were recommended for formulation of supplementary foods (Akubor *et al*. 2000) [5]. Therefore, it can be concluded that the developed malted composite flour could be used in the biscuits and supplementary foods preparation.

Sedimentation value

SDS-sedimentation volume test gives indirect measure of quantity and composition of gluten proteins. This test is also used to assess the gluten quality and bread-making potential of the flour (Belderok, 2000) [12]. Higher sedimentation volume reflects appreciable quantity of high molecular weight glutenin proteins in the flour. Such flour is recommended for the bread making (Owens, 2001) [46]. Flour with lower sedimentation volume, on the other hand, is preferred for biscuit/cookie or cake production. The analyzed sedimentation value of wheat flour and malted composite flour in the present investigation were found to be 33 ml and 23.66 ml respectively, as depicted in Table 1. According to IS :7464-1974 and PFA Rule the minimum value of sedimentation volume should be 30 and 22 ml in wheat flour for baking industries (Khatkar, 2013) [33]. After comparing the results with above standard values, present findings were found to be similar to the standards. Therefore, developed malted composite flour can be used in the baking industries. It can be observed that the sedimentation volume of wheat flour was significantly higher than that of malted composite flour. Similar results were found by Dhingra and Jood (2004) [20] in wheat, barley and soy composite flour and control (100 % wheat flour). The sedimentation value of different flour blends ranged from 26.25 to 33.12 ml and wheat flour showed the highest sedimentation value (34.25 ml). Poongodi and Jemima (2009) [47] also formulated the composite flour using wheat, kodo millet, barnyard millet and defatted soy flour. The millet blend (Kodo millet+ barnyard millet, 1:1) was incorporated into wheat flour at 10, 20, and 30% and 10% defatted soy flour was added in all combinations. They concluded that sedimentation value of composite flour decreased significantly ($p<0.05$) with increase in percent incorporation of millet flour blend which was identical to the present study.

Gluten

Gluten plays a key role in determining the unique baking quality of wheat by conferring water absorption capacity, cohesiveness, viscosity, and elasticity on dough (Wieser 2007) [55]. In addition, gluten stabilizes the gas-containing pores that are relevant for gas retention and loaf volume in baked product (Caballero *et al*., 2007) [15]. The amounts of wet and dry gluten required for preparation of desirable products have been preset commercially. Flour having wet gluten of 22-25% is suitable for biscuit and cookies production. Dry gluten for good bread flour falls in the range of 10-12%. For soft wheat products the range of dry gluten should be 8-9% (Ma *et al*. 2007) [38]. In the present study the crude gluten and wet gluten of different flour ranged between 0.86 to 10.89 % and 1.33 to 29.83 %, respectively which was found to be within this preset range of gluten by Ma *et al*., 2007 [38] (Table 2.). Similarly, Dhingra and Jood (2004) [20] investigated the effect of flour blending on gluten characteristics of wheat-soy composite flour. Soybean (full-fat and defatted) and barley flours were incorporated into wheat flour at 5, 10, 15 and 20% substitution levels. Wheat flour exhibited mean wet and dry gluten contents of 30.6 and 10.3%, respectively and significant reduction was observed in gluten content with increasing substitution level. Wheat flour blended with defatted soy flour at a substitution level of 20% had the lowest wet and dry gluten contents (22.6 and 7.7%, respectively). Other studies have been done on gluten content of wheat and composite flour by various researchers which were comparable to the results of present investigation.

Table 2: Functional Properties of Flours

S. No	Treatments	WAC (g/g)	OAC (g/g)	LGC (%)	FC (%)	FS (%)	SP (%)	Solubility (%)	Dispers-ability (%)	Maltose value (g/100g)
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
1.	WF	1.34±0.04	1.53±0.03	10.00±0.02	41.33±1.52	74.66±4.16	7.16±0.28	11.50±0.50	71.83±1.25	-
2.	MCF	1.45±0.04	1.72±0.01	16.00±0.01	33.00±2.65	62.00±1.0	12.46±0.45	12.83±0.76	67.33±2.08	1.86±0.04
3.	MCG	0.93±0.05	1.76±0.05	14.33±0.57	31.00±2.64	59.63±0.55	13.66±0.57	13.90±0.85	59.00±1.00	1.73V0.02
	CD5%	0.09	0.07	0.66	4.66	4.97	0.90	1.44	3.03	0.05
	CD1%	0.14	0.12	1.00	7.06	7.54	1.37	2.18	4.59	0.08
	CV	3.77	2.39	2.48	6.65	3.81	4.10	5.66	2.30	2.39

Where, Control= 100% refined wheat flour, T1= 1:8:1, T2=2:3:1, T3=3:6:1, T4=4:5:1 of MCG: MWF: DSF

Water-absorption capacity (WAC)

Water absorption capacity is important in bulking and consistency of product as well as in baking applications and WAC gives an indication of the amount of water available for gelatinization (Edema *et al*., 2005) [21]. Table 2. Reveals that the WAC of wheat flour was found to be significantly ($p \leq 0.05$) lower (1.34 g/g) than that of malted composite flour (1.45 g/g). The lower WAC of wheat flour could be attributed to the presence of lower amount of hydrophilic constituents in wheat flour (Akubor and Badifu, 2004) [58]. Lower water absorption capacity is due to less availability of polar amino acids in flours and this effect could be probably due to loose association of amylose and amylopectin in the native granules of starch and weaker associative forces maintaining the granules structure (Mc Watters *et al*., 2003; Nasr and Abufoul, 2004 and Falola *et al*. 2011) [39, 41, 23]. The higher water absorption capacity of malted composite flour may be due to the higher polar amino acid residues of proteins having an affinity for water molecules (Yusuf *et al*., 2008) [56]. The major chemical compositions that enhance the water absorption capacity of flours are proteins and carbohydrates, since these constituents contain hydrophilic parts, such as polar or charged side chains (Lawal and Adebowale, 2004 and El-Demery, 2011) [37, 59]. Poongodi and Jemima (2009) [47] also recorded values of WAC of composite flour (wheat, kodo, barnyard millet and defatted soy flour) ranging from 1.39 to 1.48 g/g, which was similar to the present study.

Oil absorption capacity (OAC)

It denotes how much oil is bound to matrices in particular food system which could be used as the index of hydro-phobicity of the food. Oil absorption capacity is expressed as the grams of oil bound per gram of the sample on dry basis (Deshpande and Poshadri, 2011) [19]. Oil absorption capacity is important since oil acts as flavour retainer and increases the mouth feel of foods (Aremu *et al*., 2007) [9]. As can be seen from the Table 2. presenting data on oil absorption capacity of flour, the highest value of OAC i.e 1.72 g/g was found in malted composite flour followed by wheat flour (1.53 g/g). This suggested that malted composite flour may have more hydrophobic proteins flour; the more hydrophobic proteins demonstrate superior binding of lipids (Lawal and Adebowale, 2004) [37]. Jitngarmkusol *et al*., (2008) [31] also reported that the major chemical component affecting oil absorption capacity is protein, which is composed of both hydrophilic and hydrophobic parts. Non-polar amino acid side chains can form hydrophobic interactions with hydrocarbon chains of lipid. The present study also agreed with the study of Adetuyi *et al*. (2009) [3] regarding the high oil absorption capacity of malted composite flour in comparison to wheat flour.

Least Gelation Concentration

Gelation is one of the most important functional properties which determine the suitability of incorporation of a particular substance into food products (Adebowale and Adebowale, 2008) [2]. The results for least gelation concentration of different flour analyzed in present study are shown in Table 2. The highest gelling power was observed in malted composite flour (16 %) while lowest gelling properties were noticed in case of wheat flour (10%). This variation in LGC could be attributed to the relative ratios of different constituent's proteins, carbohydrates and lipids in flour samples. Sathe *et al*., (1982) [50] reported that interaction between such component play a significant role in the functional properties. Furthermore, Adetuyi *et al*. (2009) [3] formulated the complementary blends with unmalted maize 100% (Umm); 70% unmalted maize + 30% soybeans (Umms); malted maize 100% (Mm) and 70% malted maize + 30% soybeans (Mms). It was reported that the least gelation concentration (LGC) of the flour increased after the maize (malted and unmalted) had been blended with soybean. This result suggests that soybean was responsible for increasing the LGC in cereal flours. This explanation holds true for the current study as well. Another reason of high gelation property in malted composite flour may be due to starch content of millet, sorghum. Ikpeme-Emmanuel *et al*. (2010) [30] prepared wheat and taro flour composite bread and investigated the least gelation concentration of wheat and wheat-taro composite flour. They revealed that the LGC of wheat, taro blend ranged from 6 - 8%, when compared with 100% wheat flour (control) which had a high LGC of 10%. The value of the control was significantly different ($P < 0.05$) from LGC of the composite samples. Similar value of LGC was found for wheat (10%) in the present study and it was also significantly different from experimental samples.

Foaming capacity and stability

Good foam capacity and stability are desirable attributes for flours intended for the production of variety of baked products such as angel cakes, muffins, cookies, fudges, etc and also act as functional agents in other food formulations. Foam stability (FS) describes the ability of the proteins to form strong cohesive film around air vacuole that resists air diffusion from the vacuole (Akubor, 2003) [4]. In the present research study, mean values for foaming capacity and stability of wheat flour and malted composite flour are given in Table 2. It was observed that both foaming capacity and stability were significantly ($P>0.01$) affected among different samples. Wheat flour had foaming capacity 41.33 % and foaming stability 74.66 %, whilst malted composite flour possessed 33% and 62% of foaming capacity and stability, respectively. The highest foaming capacity and stability was noted in case of wheat flour which decreased in malted composite flour. Similar results were found in the study of Poongodi and Jemima (2009) [47] in which foaming capacity of composite (wheat + millet blend + defatted soy flour) flour decreased significantly ($p<0.01$) with increase in level of millet (kodo and barnyard millet) flour blend.

Swelling Power and Solubility of flour

Swelling capacities is regarded as quality criterion in some good formulations such as bakery products. It is an evidence of non-covalent bonding between molecules within starch granules and also a factor of the ratio of α-amylose and amylopectin ratios (Osungbaro *et al*. 2010) [45]. Schoch (1964) [51] reported that the degree of swelling and amount of soluble components depends on the type and species of starch in the flour samples. Table 2. Represents the swelling capacity and solubility of flours. It can be delineated that the swelling power of malted composite flour (12.46%) was significantly ($p>0.01$) higher than wheat flour (7.16%), whereas solubility does not significantly ($p>0.01$) differ from each other. The increase in the swelling capacity could be attributed to the increase in the carbohydrate content of the blend because the carbohydrate of sorghum, barley, pearl millet and soy bean might have caused the increase in the total carbohydrate content of the blended flour. The swelling power is an indication of presence of amylase which influences the quantity of amylose and amylopectin present in the malted composite flour. Therefore, the higher the swelling power, the higher the associated forces. The variation in the swelling power indicates the degree of exposure of the internal structure of the starch present in the flour to the action of water (Kafilat, 2010) [60]. Congruent results were found by Adetuyi *et al* (2009) [3]. They reported that swelling capacity was increased in maize –soy blend in comparison to wheat flour.

Dispersability

The property of dispersability determines the tendency of flour to move apart from water molecule and shows its hydrophobic interaction. The dispersibility of a mix in water indicates its re-constitutability. The higher dispersability, the better will be reconstitution property. Higher dispersibility enhances the emulsifying and foaming properties of proteins, which was observed during making of bread, macaroni and cookies by Ali *et al* (2012) [61]. In the present investigation, the dispersibility of the flour (59 - 71.83 %) were significantly different ($p<0.01$) from each other. Wheat flour had the higher values of dispersability (71.83 %) than malted composite flour (67.33%). A study was conducted on parallel lines by Eke-Ejiofor and Owuno (2012) [22] evaluated the dispersability of wheat flour and wheat-yam (50:50) composite flour. Thus obtained result revealed much higher mean value of dispersability for wheat flour sample 68% as against 60 % in wheat-yam composite flour. Identical results were found by Kulkarni *et al*., (1991) [36] in which they reported that the percentage dispersibility of the weaning food (Sorghum malt, green gram malt and sesame flour) formulations ranged from 63 to 79.

Diastatic activity or Maltose value

The diastatic activity is the test, which reveals the extent to which the diastatic enzyme alpha-and beta-amylases produce sugars while acting on starch present in the flour. Normally, wheat has sufficient beta-amylase activity but lack in alpha-amylase activity. However, amylase activity increases thousand folds during wet harvest or germination. The diastatic activity is expressed as mg maltose produced/10 g of flour in one hour at 30°C. The optimum level as described by Khatkar (2013) [33] and Sathe (1999) [49] is between 2.5 to 3.5 (150 to 350 mg/10.0 g flour). It has been reported that the flours with maltose figure of less than 1.5% or 150 mg maltose/10g may tend to be deficient in gassing power. On the other hand, when the maltose figure is over 2.5% (250 mg per 10 g. flour), there is a danger of excess gas production so certain amount of diastatic activity in flour is most essential for bread making. For cookie and biscuit making, high diastatic activity is not desirable and the flour unfit for bread-making purposes due to low diastatic activity can easily be used for cookie/biscuit making (Khatkar, 2013) [33]. Table 2. portrays that the maltose value of malted composite flour was 1.86 mg maltose/100g whereas control (100% wheat flour) had 0 values because it was not germinated. Nirmala *et al*. (2000) [43] also stated the same outcome in their research that maltose was observed after 2 days of germination of finger millet whereas maltose was not present in ungerminated flour. As per the IS: 7464-1974, the maltose value of wheat flour should be in the range between 2.5-3.0 for baking industry. The maltose value obtained from the malted composite flour in the present study is found to be within this recommended range. Therefore it can be concluded that malted composite flour would be very useful in preparation of various baked flour based products.

Conclusion

It was observed during this work that supplementation of MCG blend with defatted soy flour had significantly improved the functional properties of whole wheat flour. The improvement in the functional properties of whole wheat flour after supplementation makes it a useful ingredient for several food products. Since the value obtained for the various physical and functional properties of the composite flour are in good agreement with the standards and reviews.

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