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PHYSICO-CHEMICAL AND FUNCTIONAL PROPERTIES OF COMPOSITE FLOUR TO DEVELOP ENRICH BREAKFAST FOOD

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ABSTRACT

The present research was carried out to study the physico-chemical and functional properties of wheat flours (durum wheat semolina) and composite flours [millet & pulse flour blends, millet flour blends (flours of barnyard millet, kodo millet, little millet mixed at equally and pulse flour blends (flours of peas and lentil) mixed at equal proportion] and it is incorporated to wheat flour at different proportions such as 15%, 30% and 45%, respectively. Durum Semolina (100%) was used as control. The physico-chemical and functional properties such as color, bulk density (g/cm3), dispensability(%), starch damage (%),water absorption capacity(%),water solubility index(%),oil absorption capacity (%),Emulsion capacity and its stability (%), foam capacity and its stability(%) were evaluated. The study was focused to determine the physico-chemical and functional properties of composite flour to develop enrich breakfast food. The flour color measurement of composite flour, which had lower whiteness L values ranges from (83.3 to 84.8), a* redness values ranges from (0.84 to 0.98) and b* yellowness of composite flour had 15.2 to 15.7.On the other hand, the total color difference (ΔE) ranges from 14.7 to 16.1, which shows positive color effect in the sense of yellowness enhancement of composite flour. Bulk density of composite flour had 0.8(g/cm3), Dispersibility of composite flour had 60 to 61% and starch damage had 8.2 % to 9.6%. Starch molecular weight decreased during processing of flour, these changes indicate that more easily hydrolyzed during digestion. Water absorption capacity (WAC) and oil absorption capacity of composite flour had 117ml/g and 116 to 121ml/g. The solubility index of flour had 9.5% to 10.3%.The emulsion capacity (EC) and its stability of composite flour had 7.5 % to 15% and 7.5 % to 10%. The foam capacity and its stability of composite flour had 23% to 35% and 13.8% to 14.5%. This composite flour has good functional properties, which enhance the nutritional quality of the value added products*

***KEYWORDS**: Composite Flour – Functional Properties – Composite Flour – Breakfast Food*

Article History

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INTRODUCTION

Consumption of whole grain and its products reduce the chronic diseases such as diabetes mellitus, cardio vascular disease, cancer and obesity. Whole grain has increased diatery fibre (arabinoxylan and cellulose), B vitamins, mineral content and phyto chemicals such as phenolic compounds, phytates and avenanthramides (slavin 2004).These additional components may have interaction with starch or other components, which result in changes to the digestibility of starch in whole grain products. Digestion and uptake of carbohydrates are slowed down when consumption of whole foods. Cereal grains contain 60 to 70% starch and are excellent energy rich food for human. Doctors recommended cereals as the first food to be added to infant diets and a healthy diet for adults should have most of its calories in the form of complex carbohydrates such as cereals grain starch. Cereals and millets form the staple food of diets in about 75% of the countries of the world (Khader, 2001).Cereals are an excellent source of vitamin and minerals including fat soluble vitamin E, which is an essential antioxidant. The cereal grains are an easy protein source as required by Recommended Daily Allowance (RDA) (Khatkar, 2005).But unfortunately they lack the essential amino acid lysine and therefore they must be used as along with the source of pulses protein. Functional properties are the fundamental physico-chemical properties that reflect the complex interaction between the composition, structure, molecular conformation and physico-chemical properties of food components together with the nature of environment, in which these are associated and measured (Kinsella, 1976; Kaur and Singh, 2006; Siddiq et al., 2009). Functional characteristics are required to evaluate and possibly help to predict how new proteins, fat, fibre and carbohydrates may behave in specific systems as well as demonstrate whether or not such protein can be used to stimulate or replace conventional protein (Mattil, 1971; Kaur and Singh, 2006; Siddiq et al., 2009). The food property is characterized of the structure, quality, nutritional value and /or acceptability of a food product. A functional property of food is determined by physical, chemical, and/or organoleptic properties of a food. Example of functional properties may include solubility, absorption, water retention, frothing ability, elasticity and absorptive capacity for fat and foreign particulars. Typical functional properties include emulsification, hydration (water binding), viscosity, foaming, solubility, gelation, cohesion and adhesion. The objective of the study involves the collection of data on the physico-chemical and functional properties (color, bulk density (g/cm3), dispersibility(%),starch damage (%) ,water absorption capacity(%),water solubility index(%),oil absorption capacity (%),Emulsion capacity and its stability (%), foam capacity and its stability(%)) of composite flour by durum wheat semolina and millet (barnyard millet, kodo millet, little millet)& pulse flour blends (peas and lentil). This provide the useful information to industry purpose and other alike on the subsequent incorporation of the different flours along with wheat flour to produce natural, cheap and acceptable functional foodsto develop enrich breakfast food.

METHODOLOGY

Raw Material

Wheat, barnyard millet, kodo millet, little millet, peas and lentil were purchased from local market

Pre Preparation of Raw Material

Durum wheat semolina barnyard millet, kodo millet, little millet, peas and lentil were cleaned, milled and pass it through 250µm mesh sieve to obtain the flour. Flour of barnyard millet, kodo millet and little millet were mixed equal proportions and Flour of peas and lentil were mixed at equal proportions. Then both millet flour blends and pulse flour blends were mixed at 1:1 ratio. It was subsequently stored in a sealed plastic container at room temperature for further processing.

Preparation of Flour Sample

The composite flour blends incorporated to wheat flour at different proportions such as 15%, 30% and 45%. Durum wheat flour was used as control (100%). The composite flours and control were stored separately in tightly covered plastic jars to prevent moisture re-absorption. Further, the composite flour and wheat flour were subjected to analyse the physico-chemical and functional properties that is, solubility index (%), water absorption capacity (WAC, %), oil absorption capacity (OAC, %), emulsion activity (EA, %), emulsion stability (ES, %), foam capacity (FC, %), foam stability (FS, %), color and bulk density (g/cm3).

Determination of Physico-Chemical Properties of Composite Flour

Color

Colour (L*, a*, b* values) of the samples wasdetermined by using Hunter Colour Flex Meter. L* is known as the lightness and extends from 0 (black) to 100(white). The other two coordinates a* and b* represent redness (+ a) to greenness (- a) and yellowness (+ b) to blueness (-b), respectively were recorded. Three measurements were taken for each sample and their means were reported.

Bulk Density (g/cm^3)

The volume of 100 g of the flour was measured in a measuring cylinder (250 ml).The measuring cylinder was tapped on a wooden plank continuously after tapping the cylinder until no visible decrease in volume was noticed, and based on the weight and volume, the apparent (bulk) density was calculated (Jones et al., 2000).

$$\text{Bulk density (g/ml)} \quad \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$$

Dispersibility (%)

This was determined by the method described by Kulkarni etal.(1991). The flour sample (10g) was weighed into a graduated cylinder. Water was added to the make up to 100ml mark. It was shaken vigorously, and allowed to stand for 3h.The volume of settled particles was recorded.

Starch Damage (%)

The Megazyme method (figure 2) involves the hydrolysis of the damaged starch granules using fungal alpha amylase. The resultant maltosaccharides and dextrin's are completely degraded to glucose by mean of amyloglucosidase. The liberated glucose is then reacted further with a glucose oxidase/peroxidises reagent mixture and quantified spectroscopic ally. High glucose reading, results the greater the starch damage. According to Medcalf, D. and Gilles, K. (1965).

Weigh 100±10mg of flour in a 12mL tube
⇩
Equilibrate at 40°C for 2-5min
⇩
Add 1mL of fungal alpha amylase solution (50U/mL) pre-equilibrated at 40°C. Vortex
⇩
Incubate at 40°C for precisely 10min
⇩
Stop the enzymatic reaction by adding 8mL of diluted sulphuric acid (0.2% v/v)
⇩
Centrifuge at 3000rpm for 5min
⇩
Add 0.1mL aliquot to test tube. Add 0.1mL amyloglucosidase solution
⇩
Incubate at 40°C for 10min
⇩
Add 4mL of GOPOD reagent
⇩
Incubate at 40°C for 20min
⇩
Measure absorbance at 510nm (spectrophotometer)

Figure 1: Starch Damage Procedure.

Water/Oil Absorption Capacity (WAC/OAC (%)

The water absorption capacity of the flours was determine by the method of Sosulski et al. (1976). One gram of sample mixed with 10 mL distilled water and allow to stand at ambient temperature (30 ± 2°C) for 30 min, the centrifuged for 30 min at 3000 rpm or 2000 × g. Oil absorption was examined as percent oil bound per gram flour. The oil absorption capacity was determine by the method of Sosulski et al. (1976). One gram of sample mixed with 10 ml soybean oil (Sp. Gravity 0.9092) and allow to stand at ambient temperature (30 ± 2°C) for 30 min, the centrifuged for 30 min at 300 rpm or 2000 × g. The water and oil absorption capacities were express in grams of water/oil absorbed per gram of flour sample.

Water Solubility Index (%)

WSI were determined in triplicate following the method described by Carine et al., 2010. Each sample (1 g) would suspend in 20 mL of distilled water in a tared 45 mL centrifuge tube, and be stirred with glass rod then put in water bath for 30 min at 30°C temperature then centrifuge at 3,000 r min-1 for 15 min. The supernatants would pour into dry evaporator dishes of known weight and stored overnight at 120°C for the process of evaporation. WAI and WSI would be calculating using following equations:

$$WSI = \frac{\text{Weight of dissolved solids in supernant}}{\text{Weight of dry samples in the original sample}} \times 100$$

Emulsion Capacity and its Stability (%)

The emulsion activity and stability by Yasumatsu et al. (1972) described and followed, as the emulsion (1 g sample, 10 ml distilled water and 10 ml soybean oil) was prepared in calibrated centrifuged tube. The emulsion was centrifuged at 2000 × g for 5 min. The volume of oil, which separated from the sample after centrifugation was read directly from the tube. Emulsion activity was calculated as the ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion activity in expressedasa percentage. The emulsion stability was estimated after heating the emulsion contained in calibrated centrifuged tube at 80°C for 30 min in a water-bath, cooling for 15 min under running tap water and centrifuging at 2000 × g for 15 min. The emulsion stability expressed as percentage was calculated as the ratio of the height of emulsified layer to the total height of the mixture.

Foam Capacity and its Stability (%)

The foam capacity (FC) and foam stability (FS) by Narayana and Narasinga (1982) were determined as described with slight modification. The 1.0 g flour sample was added to 50 mL distilled water at 30 ± 2°C in a graduated cylinder. The suspension was mixed and shaken for 5 min to foam. The volume of foam at 30 sec after whipping was expressed as foam capacity using the formula:

$$\text{Foam capacity (\%)} = \frac{\text{Volume of foam after whipping} - \text{Volume of foam before whipping}}{\text{Volume of foam before whipping}} \times 100$$

The volume of foam was recorded one hour after whipping to determine foam stability as per percent of initial foam volume.

STATISTICAL ANALYSIS

The data obtained from the various experiments were recorded during the study and were subjected to statistical analysis as per method of “Analysis of variance” by Factorial Randomized Block Design (factorial R.B.D.). The significant difference between the means was tested against the critical difference at 5 % level of significance (Gomez and Gomez, 1984). INSTAT software was used to analyze the recorded data.

RESULTS AND DISCUSSIONS

Table 1

Functional Properties	Control	Millet & Pulse Flour Blends Variation Substituted with Durum Wheat Flour		
		at 15%	at 30%	at 45%
a. Solubility index (%)	10.4±0.1	9.5±1.1*	10.3±0.1 ns	10.3±0.3 ns
b. Water absorption capacity (ml/100g)	136.1±1.4	117.8±1.6**	117.7±1.4**	117.4±1.68**
c. Oil absorption capacity (ml/100g)	118.7±0.8	116.9±2.3 ns	118.8±2 ns	121.3±0.6 ns
d. Emulsion capacity (%)	7.5±0.2	7.5±0.2 ns	10±0.1**	15±0.1**
e. Emulsion stability (%)	7.5±0.1	7.5±0.1 ns	10±0.1**	10±0.1**
f. Foam capacity (%)	23.0±0.09	23.0±0.1 ns	35.8±0.1**	22.5±0.1**
g. Foam stability (%)	13.84±0.2	13.84±0.1 ns	14.92±0.1**	14.51±0.1**

Note: The values are expressed as the mean of three replicate samples ± standard deviation. *** = 0.1% Significance Level; ** = 1% Significance Level;* = 5% Significance level; NS = Not Significant

Water absorption capacity (WAC) and oil absorption capacity of composite flour had 117ml/g and 116 to 121ml/g. Water absorption was significant to control ($P<0.05$).WAC is important in bulking and consistency of product as well as baking applications. Oil gives soft texture and good flavour to food. Therefore absorption of oil by food products improves mouth feel and flavour retention. Oil absorption capacity was no significant to control ($P>0.05$).The solubility index of flour had 9.5% to 10.3% which was no significant to control ($P>0.05$) except 15% of composite flour. The emulsion capacity (EC) and its stability of composite flour had 7.5 % to 15% and 7.5 % to 10%. The differences in EC, their solubility exhibited the lowest emulsifying activity and highest emulsion stability. Hydrophobicity of protein has been attributed to influence their emulsifying properties which enhance the formation and stabilization of emulsions, it is important for many applications in food products like cake, coffee whiteners and frozen desserts. The foam capacity and its stability of composite flour had 23% to 35% and 13.8% to 14.5%.The variance in foam capacity due to protein content in flour. Protein in the dispersion may cause a lowering of the surface tension at the water air interface, thus always been due to protein which forms a continuous cohesive film around the air bubbles in the foam. The emulsion and foam capacity and its stability of composite flour which was significant to control ($P<0.05$) except 15% of composite flour.

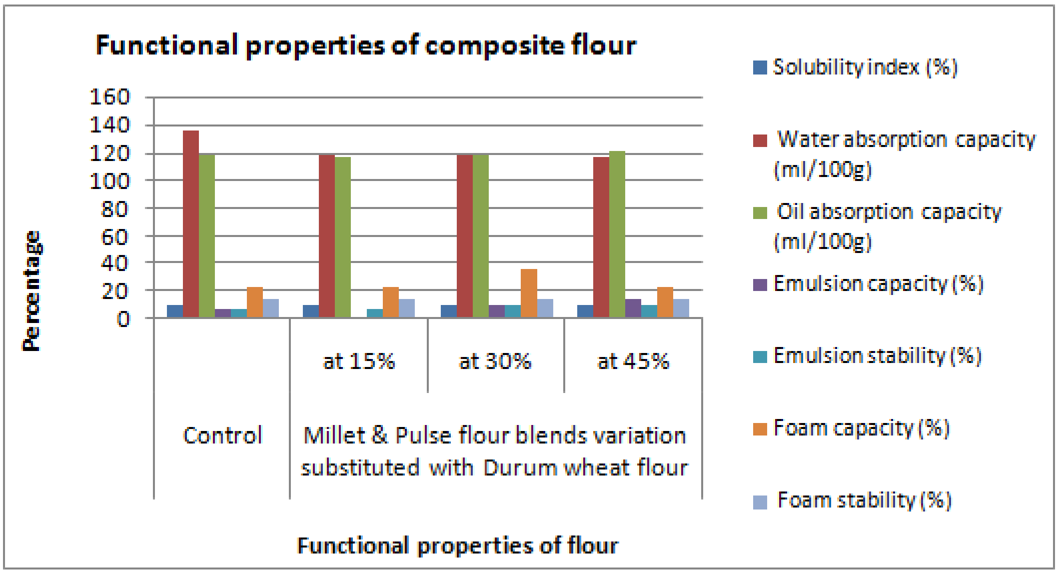

Figure 2: Functional Properties of Composite Flour.

Table 2

Physical Properties	Control	Millet & Pulse Flour Blends Variation Substituted with Durum Wheat Flour		
		at 15%	at 30%	at 45%
a. Colour				
L	86±0.06	84.8±0.1**	84±0.02**	83.3±0.03**
a	0.72±0	0.84±0 ns	0.86±0.01*	0.98±0**
b	14.6±0.04	15.2±0.08**	15.3±0**	15.7±0.01**
de	13.6±0	14.7±0.06**	15.3±0.01**	16.1±0.01**
b. Bulk density (per 100g)	0.8±0	0.83±0 ns	0.83±0 ns	0.83±0 ns
c. Dispersibility (%)	62±0	60±0**	60±0**	61±0 ns
d. Starch damage (%)	7.7±0	8.2±0**	9.6±0.7**	8.8±0.3**

Note: The values are expressed as the mean of three replicate samples ± standard deviation.
*** = 0.1% Significance Level; ** = 1% Significance Level;* = 5% Significance level;
NS = Not Significant

The flour color measurement confirmed its dependence on ratio of composite flour, which had lower whiteness L* values ranges from (83.3 to 84.8), a* redness values ranges from (0.84 to 0.98) and b* yellowness of composite flour had 15.2 to 15.7 .On the other hand, the total color difference (ΔE) ranges from 14.7 to 16.1 which shows positive color effect in the sense of yellowness enhancement of composite flour which was significant to control ($P<0.05$). Bulk density of composite flour had 0.8(g/cm3) which was no significant to control ($P>0.05$).Bulk density gives an indication of the relative volume of packaging material required. Low bulk densities of flour are good physical attributes when determining transportation and storability since the products could be easily transported and distributed to required locations. Dispersibility of composite flour had 60 to 61% which was significant to control ($P<0.05$) except 45% of composite flour and starch damage had 8.2 % to 9.6%, which was significant to control ($P<0.05$). Starch molecular weight decreased during processing of flour, these changes indicate that more easily hydrolyzed during digestion.

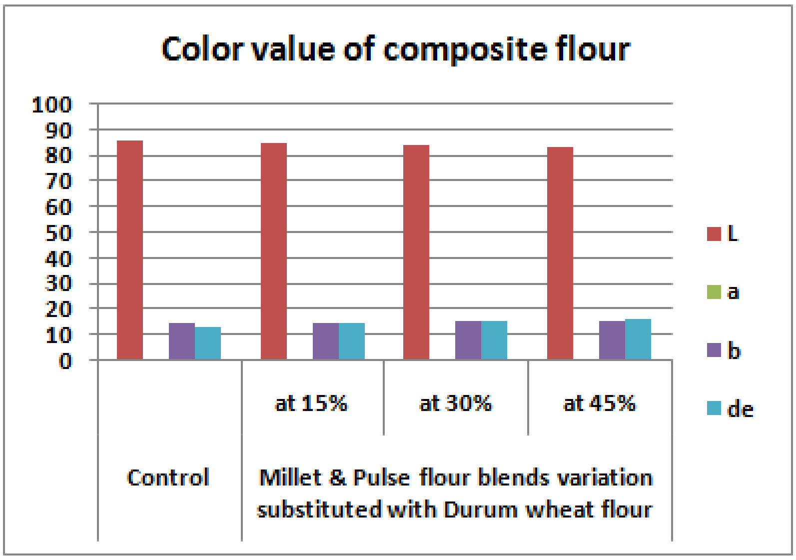

Figure 3: Color Values of Composite Flour.

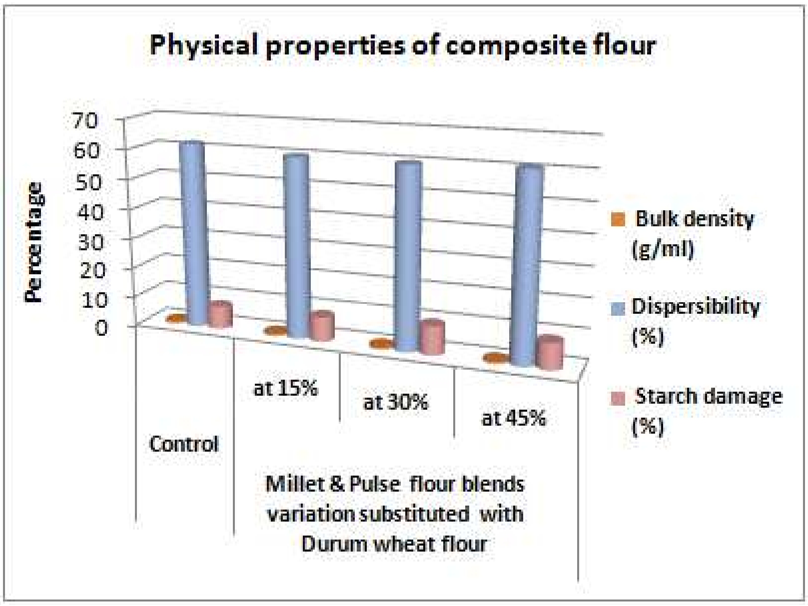

Figure 4: Physical Properties of Composite Flour.

CONCLUSIONS

In the recent research, there is a trend to use novel sources of protein, fat, vitamins, minerals rich food to decrease the proportion of wheat flour by using locally available cheap and nutritional sources. This composite flour have good functional properties, which enhance the nutritional quality of the value added products which processed by addition of them. This study, therefore recommends extensive cultivation and utilization of these millet varieties. Meanwhile, consumption of these products should be accompanied with protein rich diets such as legumes, in order to eat a nutritionally balanced diet, since they could serve as useful supplements for breakfast food such as pasta and bakery products.

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