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Effect of Substitution of Wheat with Maize on Technological and Organoleptic Properties of Chapatties

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Abstract

Unleavened flat bread (chapatti) was prepared from wheat (*Tritium aestivum*) and maize (*Zea mays*) composite flour. The wheat flours from mill and grindstone were collected from local market and blended with maize flour in 100:0, 90:10, 80:20 proportions. Technological and rheological studies revealed that gluten, falling number and water absorption values decreased with increased maize proportion. Increased dough development time by addition of 20% maize flour for either flour types was observed. Decrease in dough stability was observed by increased maize proportion in grindstone flour but in mill flour decrease with 10% maize and increase with 20% maize is noted. Overall Farinographic quality was highest in 20% blend of maize in grindstone flour. Chapatties were prepared and subjected to organoleptic tests by a panel of trained judges and 20% blend get maximum acceptability.

Keywords: Wheat-maize composite flour, organoleptic, chapatti, Pakistan

Introduction

Wheat (*Tritium aestivum*) has been the most important cereal crop of world in terms of both areas cultivated and grain yield. Wheat flour is a staple food of Pakistani people and an average intake is 318 g per person per day. More than 50% of the total energy intake is derived from wheat flour (Omni, 1996). Wheat is principally used for the production of unleavened flat bread locally known as Chapatti in Pakistan (Khan and Ullah, 1984). In Pakistan, wheat is used for the preparation of several products such as chapatties, paratha (fried unleavened bread), nan (oven unleavened bread), bread, buns, biscuits, cakes, pastries, patties, pan cakes and many others (Pyler, 1988). Chapatti is unleavened flat bread baked on conventional hot plate tawa or in conventional ovens tandoor (Kent, 1984). Chapatties are least expensive and utilize almost 90% of the total wheat produced in this region (Siddique, 1989) during the last three years. In spite of good crop, Pakistan had to resort to wheat import for avoiding food shortages. About 3-10% of the domestic requirements (on an average 2 million tons) are meeting through imports. In order to lessen he load on wheat as staple food, and to fill in the annual short fall it is possible to substitute wheat with different cereals and pulses for making chapatti. Maize ranks as the second most widely produced cereal crop worldwide. Because of the high productivity, corn is by far the most economical cereal to produce. By substituting part of the wheat flour with maize flour the lowering of the costs can be achieved (Păucean & Simona, 2013). Flours

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from amaranth grain (Ayo, 2001) plantain (Bamidele *et al*., 2006), rice/corn/soybean (Sabanis & Tzia, 2009) and cassava (Shittu *et al.,* 2007) were respectively composited with that of wheat in the production of bread so as to determine he technical feasibility as well as to find a means to reduce the importation of wheat grains from the developed countries with associated benefit of minimizing wastage of scarce foreign exchange (Bolade, 2012). The present work was plane with the objective to develop wheat-maize composite flour of different proportions ranging from 10-20% substitution of mill and grindstone wheat flour with maize flour and determined how composite flour perform in chapatti making methods.

Materials and methods

Commercial wheat (grindstone and mill) and maize flour were procured from local market of Islamabad during 2013. Composite flours were then prepared using different wheat/maize ratios. (100:0, 90:10, 80:20) Composite flour samples were stored in polypropylene bags. Chemical, farinographic analysis of composite flours and organoleptic evaluation of prepared chapatties were done.

Technological and farinographic studies

The prepared composite flours were subjected to wet/dry gluten and falling number analysis according to standard procedure of (AACC 2000). Perten Glutomatic was used to determine wet/dry gluten and Falling number system (Perten 1500) was used to determine alpha amylase activity in composite flours. Rheological behaviors of wheat/maize composite flour samples were evaluated by Brabender Farinigraph equipped with a bowl of 50 g capacity. The dough characteristics such as water absorption, dough development time, dough stability, tolerance index and softening of dough were determined according to standard procedure of AACC (2000).

Dough preparation and molding for chapatti

The test baking chapatti method was derived from those described by (Austin and Ram, 1971; Haridas *et al.,* 1986). Dough weighing 65g was made into a ball. After 5 minutes rest the ball was flattened into a 7 inches round disc using wooden rolling pin and with moderate dusting. The dough disc was baked on hot iron plate (tawa) placed on gas burner.

Organoleptic evaluation

Baked chapatties when fresh were served to a panel of 10 judges for organoleptic evaluation. The emphasis was centered on color, taste, flavor, texture, chewability. Samples were presented in succession and panelists were asked to rate evaluation variables according to 9 point Hedonic scale described by (Larmond, 1997).

Statistical analysis

The data was analyzed statistically by complete randomized design (CRD) are described in statistical procedure for agriculture research by Gomez and Gomez (1984).

Results and discussion

Gluten and falling number

Following flour quality requirements should be kept in mind for making chapatti. Moisture 10-12%, wet gluten>25% water absorption 65-70% and sufficient water retention capacity even after dehydration by cooking to give it a soft and pliable texture (Shurpalekar & Prabhavathi, 1976; Ebeler & Walker, 1983; Rao *et al.,* 1986). Gluten contents are the important factors affecting quality of chapatti. It must be more than 25% for a good chapatti. As shown in Table 1 the addition of maize flour to wheat flour resulted in a significant reduction in gluten values. The gluten contents decreased significantly as the percentage of maize flour substitution increased, this might be attributed to the fact that the maize flour is essentially considered as gluten free grain (Hopman *et al.,* 2008). Wheat flour blended with maize on substitution level of 20% had the lowest wet and dry gluten contents (14.0% & 4.0% for grindstone flour and 16.5% & 5.0% for mill flour). The dry gluten content is a direct indicator of flour strength and chapatti making potentialities. The quantity and quality of gluten is responsible for desirable characteristic of product (Anjum & Walker, 2000; Belderok, 2000).

In case of chapatti the α-amylase (table 2) must have acted on the starch during the short period of mixing and resting (5 min and 30 min respectively at 25^{o}C) and during the baking stage. Generally, a falling number value of 350 seconds or longer indicates low enzyme activity and very sound wheat and values below 200 seconds indicate high levels of enzyme activity evident (Buriro *et al.*, 2012). As the enzyme activity increases, the falling number decreases. Falling number values below 200 measures the liquefaction of gelatinized starch by the alpha amylase. These results are similar with that reported by Shad *et al.* (2013) who found that there is overall decrease in falling number in different wheat/maize proportions.

Table 1: Technological properties of different composite flour

Flour type	Grindstone Flour			Mill Flour			
Flour Composition	Wheat : Maize 100 : 0	Wheat :Maize 90 : 10	Wheat : Maize 80 : 20	Wheat : Maize 100 : 0	Wheat : Maize 90 : 10	Wheat : Maize 80 : 20	Wheat : Maize 0:100
Moisture %	10.82 d	10.88 d	10.93 d	15.92 a	15.50 b	15.40 b	11.78 c
Wet gluten %	16.5 c	15.0 d	14.0 e	18.4 a	17.5 b	16.5 c	---
Dry gluten %	4.5 c	4.5c	4.0 d	5.5 a	5.0 b	5.0 b	---
Falling number	542.7 c	462.0 d	398.0 e	724.0 a	534.0 b	506.0 c	314.0 f

* Values with common alphabets are statistically insignificant at 0.05

Farinigraphic properties

Farinographic studied were conducted to determine the rheological properties of wheat/maize composite flour. Higher water absorption is required food good chapatti characteristics which remain soft for a longer time (Simon, 1987). There is overall decrease in water absorption of substituted grindstone flours and increase in substituted mill flours. Addition of 20% maize flour increased dough development time of either flour type but significantly of grindstone flour (7.2 min). Dough stability in the case of grindstone flour increased by 10 % maize substitution and decreased by 20% maize substitution but in mill flour decrease by 10 % maize substitution and increase by 20 % maize substitution. This behaviour was correlated with different grinding techniques of wheat flours. Overall farinographic quality was highest in 20% blend in mill flour.

Table 2: **Farinographic properties of different composite flours**

Flour type	Grindstone Flour			Mill Flour		
Flour Composition	Wheat : Maize 100 : 0	Wheat : Maize 90 : 10	Wheat : Maize 80 : 20	Wheat : Maize 100 : 0	Wheat : Maize 90 : 10	Wheat : Maize 80 : 20
Water absorption	64.3 a	63.5 b	62.9 c	56.6 e	57.1 d	57.2 d
DDT/Peak Time (min)	6.5 b	5.8 c	7.2 a	3.8 f	4.5 d	4.2 e
Stability	2.6 d	2.7 d	2.0 e	4.4 a	3.8 c	4.5 a
Departure time/Break time (min)	8.6 b	8.2 b	10.8 a	7.5 c	6.3 d	6.6 d
MTI (Fu)	47 d	57 d	39 e	39 e	60 a	56 c
FQ No.	86 b	82 c	108 a	75 d	63 f	66 e

* Values with common alphabets are statistically insignificant at 0.05

Organoleptic evaluation

Chapatties prepared from different wheat-maize composite flours was subjected to sensory evaluation for color, texture, pliability, tearability, taste, flavor and their mean score were collected (table 3). Chapatties from substituted mill flour were most preferred in overall rank and from substituted grindstone flour were least preferred in taste and chew ability and overall rank which may be correlated to less moisture content and gluten content in substituted grindstone flour as compared to substituted mill flour. For chapatti, the water absorption had the highest correlation with most of the sensory attributes, particularly in texture and taste, as water absorption decreased with increased maize proportion chapatties become harder. Dough development time (DDT) had practically no impact, whereas dough stability (DS) was correlated well with many of the attributes, including texture and taste. A wheaty aroma and taste is desirable with a non sticky, soft chewing feel in mouth (Dhaliwal *et al.*, 1996). So 20% substituted mill flour was maximum acceptable in all flours.

Table 3: Organoleptic properties of chapatties

Flour type	Grindstone Flour (whole meal)			Mill Flour		
Flour Composition	Wheat : Maize 100 : 0	Wheat : Maize 90 : 10	Wheat : Maize 80 : 20	Wheat : Maize 100 : 0	Wheat : Maize 90 : 10	Wheat : Maize 80 : 20
Color	7.60 abc	6.40 ef	5.70fg	8.30a	7.40 bcd	7.60 abc
Texture	6.60 bcd	6.0 de	6.40 cd	8.0a	7.00 bc	7.40 ab
Pliability	7.30a	7.00 ab	6.30 bc	7.90a	7.10 ab	7.40a
Tearability	7.30a	6.6b	7.10ab	7.10 ab	6.83 ab	7.30 ab
Chew ability	7.60a	7.00 ab	7.30 ab	7.30 ab	7.60 a	7.30 ab
Taste	5.60cd	5.10d	5.0d	7.0a	6.60 ab	6.40 ab
Flavor	7.40a	6.70 abc	6.30 bc	7.40a	7.40a	7.40a
Mean	7.06	6.40	6.30	7.39	7.13	7.26

* Values with common alphabets are statistically insignificant at 0.05

Conclusion

As the functional properties and proximate composition of the wheat/maize composite flours were slightly different from that of 100% wheat flour, it was found that chapatties baked with 10 and 20% composite flour were significantly different from the control (100%) in most of the sensory attributes and overall acceptability. However chapatties baked with 20% composite flour had maximum acceptability.

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