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Chemical Characteristics of Various Composite Flours

NAUREEN SHAHZADI, MASOOD S. BUTT, SALEEM UR REHMAN AND KAMRAN SHARIF
Institute of Food Science and Technology, University of Agriculture, Faisalabad-38040, Pakistan

ABSTRACT

Sixteen treatments of composite flours were prepared by blending commercial wheat flour "*resultant atta*" with various legumes i.e. lentil, chickpea and guar gum in different proportion to evaluate the effect of blending on chemical characteristics. Means squares for proximate assay of composite flours showed significant differences due to storage on moisture, protein and fat while fiber, ash and NFE differed non-significantly. Means for moisture showed an increasing trend while in protein and fat a declining tendency was observed with storage. Likewise, treatments proved a momentous contribution in crude content of protein, fat, fiber, ash and NFE that varied from 12.75 to 14.03, 1.39 to 1.93, 1.92 to 2.15, 1.34 to 1.50 and 80.67 to 82.35%, respectively in different composite flour samples. Acidity, peroxide value and phytic acid varied significantly due to storage and their means diverse from 0.19 to 0.31%, 0.53 to 0.99 mEq/Kg and 0.67 to 0.59%, respectively from beginning to the end of study period. Data suggests that addition of lentil, chickpea and guar gum in commercial wheat flour significantly affects the chemical composition of composite flours.

Key Words: Composite flour; Proximate composition; POV; Acidity; Phytic acid

INTRODUCTION

Cereal grains and legumes play an important role in supplying the nutrients and more than 70% of the daily energy requirements (Edwards *et al.,* 1971). Composite flour technology refers to the process of mixing wheat flour with cereals and legumes to make economic use of local raw material to produce high quality food products. Cereal-pulse combinations have been employed for the production of various products. In addition to being rich protein source, pulses are being recognized as having therapeutic/medicinal properties. It is apparent that composite flour prepared by blending wheat and legumes in proper proportions can provide the required amino acids to the consumer.

Wheat (*Triticum aestivum* L.) is the most important cereal crop of world in terms of both areas cultivated and grain yield. In Pakistan, wheat varieties have been found to contain, on an average, moisture 9.69 to 10.35%, protein 9.57 to 14.3%, crude fat 1.47 to 2.93%, ash 1.48 to 2.03% and crude fiber 0.98 to 1.43% (Khan *et al.,* 1987). Comparison of chemical composition of legume flours and their concentrates with semolina showed that all legume flours contained significantly higher protein, ash, fiber and fat contents than the semolina (Bahnassey *et al.,* 1986). Chickpea is valued for its nutritive seeds with high protein content, 25.3-28.9 %, after dehulling (Hulse, 1991). The mean value of protein (25.4 vs. 24.4%), fat (3.7 vs. 5.1%), carbohydrate (47.4 vs. 55%), crude fiber (11.2 vs. 3.9%), ash (3.2 vs. 2.8%) and caloric value (327 vs. 365 kcal/100 g) were for desi (black-hulled) vs. kabuli (white-hulled) chickpeas, respectively. Moreover, the chickpeas seed contain 21.1% protein, 3.1% fat, 53.4 % carbohydrate, 11.1% fiber and 5.9% ash (Khan *et al*., 1995). Leelavathi *et al.* (1984) concluded that during to storage, rancidity developed in whole wheat flour but it is comparatively less than resultant *atta* (commercial wheat flour), which had bitter taste and odor. At moisture content higher than 12%, risk of fat oxidation and development of rancidity increases which is catalyzed by presence of metal ions such as Cu^{2+} and Fe^{3+}. Acidity of flour increased from 33 to 37 mmol per kg during three months of storage (Haruska & Machova, 2002), which may be attributed to the accumulation of linoleic and linolenic acids during storage which are then oxidized (Kent & Evers, 1994). An increase in rancidity from 1.4 to 2.91% after 6 weeks of storage has been observed (Misfa *et al.,* 2000). Phytate constitutes 1-2% of weight of many cereals (Torre *et al*., 1991). Anjum *et al.* (2002) determined 2.23% phytic acid in whole wheat flour of Pakistani wheats. The reduction in iron and phytic acid content has also been noted due to persisting humid and hot condition during storage or reactions of iron with other food components such as proteins, phytic acid and carbohydrates (Misfa *et al*., 2000).

MATERIALS AND METHODS

Commercial wheat flour, guar gum, chickpea and lentil were procured from the local market. The legumes were cleaned manually to remove extraneous materials. The particle size of treated dehulled chickpea, lentil and guar gum was reduced into fine flour through sample mill (Cyclotec-1093, Tecator, Sweden). Wheat flour was blended with lentil, chickpea and guar gum in different combinations (Table I). Composite flour samples were stored in polypropylene bags. Each treatment of composite flour samples was analyzed for moisture, ash and crude content of protein, fat and fiber and nitrogen free extract (NFE) at 0, 30 and 60 days intervals according to their

Table I. Different treatments used to prepare composite flours

Treatments	Wheat flour %	Lentil %	Chickpea %	Guar gum %
T_1	100	-	-	-
T_2	95	5	-	-
T_3	92.5	7.5	-	-
T_4	90	10	-	-
T_5	95	-	5	-
T_6	92.5	-	7.5	-
T_7	90	-	10	-
T_8	99	-	-	1
T_9	98	-	-	2
T_{10}	97	-	-	3
T_{11}	94	5	-	1
T_{12}	91.5	7.5	-	1
T_{13}	89	10	-	1
T_{14}	94	-	5	1
T_{15}	91.5	-	7.5	1
T_{16}	89	-	10	1

T_1 = Commercial wheat flour
T_2 = lentil 5%
T_3 = lentil 7.5%
T_4 = lentil 10%
T_5 = chickpea 5%
T_6 = chickpea 7.5%
T_7 = chickpea 10%
T_8 = guar gum 1%
T_9 = guar gum 2%
T_{10} = guar gum 3%
T_{11} = lentil 5%+ guar gum 1%
T_{12} = lentil 7.5%+ guar gum 1%
T_{13} = lentil 10%+ guar gum 1%
T_{14} = chickpea 5%+ guar gum 1%
T_{15} = chickpea 7.5% + guar gum 1%
T_{16} = chickpea 10%+ guar gum 1%

respective methods (AACC, 2000). Total acidity of the samples was determined at 0, 30, and 60 days by titrating the flour solution against NaOH (AACC, 2000). Peroxide value was measured (Kirk & Sawyer, 1991) at the stated intervals up to two months. Phytic acid content of commercial wheat flour and composite flour samples was determined at 0, 30 and 60 days interval by following the method of Haug and Lantszch (1983). Analysis of variance for each parameter was carried out to determine the level of significance as described by Steel *et al.* (1997).

RESULTS AND DISCUSSION

Chemical analysis of composite flours. Chemical analysis of composite flour (Table II) revealed that various treatments of composite flours significantly affected the crude content of protein, fat, fiber, ash, NFE and phytic acid content, whereas moisture, acidity and peroxide value (POV) remained unaffected. Moisture, acidity and POV increased while protein, fat and phytic acid was decreased due to storage from the beginning to the end. Fiber, ash and NFE were not, however, affected by the storage.

The moisture content of composite flour samples along with the commercial wheat flour (Table III) were not significantly affected. Moisture content of flour samples in present study ranged from 11.47% to 11.61%, compared to reported value of 11 to 15% depending upon storage conditions and hygroscopic nature of starch (Whiteley, 1970). Maximum increase in protein content (14.03%) was observed in composite flour containing 10% lentil. Crude protein increases with the addition of lentil in commercial flour due to high protein content of lentil (25%) as reported by Pirman (1998). The addition of guar gum decreased the percentage of crude protein contents. Highest crude fat content (1.93%) was observed in T_7 (chickpea 10%) followed by 1.85% and 1.83% in T_6 (chickpea 7.5%) and T_{16} (chickpea 10% + guar gum 1%), respectively. It was observed that as the chickpea level increases the crude fat percentage also increase progressively in composite flour samples while an inverse relation existed with the addition of lentil. Similar was the case with the addition of guar gum. The initial fat content of the raw material affected the fat content of the respective composite flour (Table III). Pirman (1998) reported crude fat content in lentil to be 1%. Similarly findings of Siddique (1989) for wheat flour and lentil are further support the present investigation. Highest significant value (2.15%) was observed in T_4 (lentil 10%). Addition of lentil and chickpea @ 10% in commercial wheat flour increase the value for crude fiber content. The highest value (1.52%) for ash content was noted in the T_{16} (chickpea 10% + guar gum 1%) due to presence of higher amounts of lentil and chickpea in the above mentioned treatments of composite flour. Lentil and chickpea have higher levels of ash content i.e. 2.51 % and 2.74%, respectively that certainly increased the ash contents. In contrast greater the amount of guar gum lowered the value of ash content in the composite flours. Siddique (1989) reported that wheat flour contained 1.71% ash contents while lentil contained 2.51% ash contents. Higest NFE content was found in T_{10} (82.35%) followed by T_9 (82.32%) and T_8 (82.29%). Siddique (1989) reported that whole wheat flour contained 80.43% NFE contents while lowest in case of chickpea 68.19%.

Phytic acid content of various composite flours (Table III) ranged from 0.54 to 0.81%. Maximum phytic acid content (0.81%) was observed in T_1 as compared to various composite flours. The treatments T_7 (chickpea 10%) and T_{13} (lentil 10% + guar gum 1%) contained the minimum content of phytic acid (0.54%).

There was gradual increase in moisture contents in various composite flour samples with increase in storage period (Table IV). Minimum moisture content 10.93% was observed at the start of the study while maximum moisture content 12.14% after 60 days storage due to the hygroscopic nature of the flour and change in the relative humidity during storage. The water content should be below 14% to prevent microbial growth and chemical changes during storage (Pyler, 1971). In the preset study commercial wheat flour was used with moisture content 11.61% that also follow the similar trend.

Table II. Mean squares for proximate composition of different flour samples

S.O.V	df	Moisture	Protein	Fat	Fiber	Ash	NFE	Acidity	POV	Phytic acid
Storage	2	17.605**	2.811**	0.090*	0.009^{NS}	0.002^{NS}	2.896^{NS}	0.175**	2.554**	0.076**
Treatments	15	0.034^{NS}	1.425**	0.274**	0.042**	0.024**	3.566**	0.002^{NS}	$.044^{NS}$	0.041**
S x T	30	0.003^{NS}	0.002^{NS}	0.001^{NS}	0.000^{NS}	0.000^{NS}	0.347^{NS}	0.001^{NS}	0.001^{NS}	0.000^{NS}
Error	96	0.024	0.219	0.022	0.007	0.009	0.941	0.002	0.027	0.012
Total	143									

** = $P \leq 0.01$
* = $P \leq 0.05$
NS = Non significant

Table III. Effect of different treatments on chemical composition of composite flours

Treatments	Moisture	Protein	Fat	Fiber	Ash	NFE	Acidity	POV	Phytic acid
T_1	11.61	13.05 def	1.63 cde	2.05 bcde	1.34 c	81.92 ab	0.23	0.77	0.81 a
T_2	11.50	13.53 abcd	1.46 ef	1.99 def	1.43 abc	81.59 abc	0.22	0.67	0.67 bc
T_3	11.49	13.75 abc	1.44 ef	1.99 def	1.46 ab	81.36 abc	0.24	0.66	0.68 b
T_4	11.46	14.03 a	1.39 f	2.15 a	1.48 ab	80.95 bc	0.25	0.66	0.61 bcd
T_5	11.50	13.37 cd	1.75 abc	2.08 abc	1.44 abc	81.36 abc	0.26	0.81	0.68 bc
T_6	11.42	13.59 abc	1.85 ab	2.11 ab	1.46 ab	80.99 bc	0.26	0.87	0.65 bcd
T_7	11.46	13.78 abc	1.93 a	2.13 ab	1.50 a	80.67 c	0.26	0.86	0.54 d
T_8	11.54	12.88 ef	1.52 def	1.92 f	1.39 bc	82.29 a	0.26	0.69	0.66 bcd
T_9	11.60	12.81 f	1.50 def	1.98 ef	1.38 bc	82.32 a	0.23	0.72	0.56 bcd
T_{10}	11.61	12.75 f	1.50 def	2.02 cde	1.38 bc	82.35 a	0.27	0.72	0.56 cd
T_{11}	11.50	13.45 cd	1.52 def	1.98 ef	1.42 abc	81.64 abc	0.27	0.73	0.65 bcd
T_{12}	11.47	13.69 abc	1.48 ef	2.06 bcde	1.46 ab	81.31 abc	0.26	0.74	0.60 bcd
T_{13}	11.48	13.97 ab	1.41 f	2.13 ab	1.50 a	80.99 bc	0.26	0.74	0.54 d
T_{14}	11.51	13.32 cde	1.69 bcd	2.07 abcd	1.44 abc	81.48 abc	0.27	0.81	0.63 bcd
T_{15}	11.47	13.50 bcd	1.76 abc	2.12 ab	1.49 a	81.13 bc	0.27	0.82	0.64 bcd
T_{16}	11.41	13.74 abc	1.83 ab	2.10 abc	1.52 a	80.81 c	0.28	0.83	0.59 bcd

Mean values for treatments carrying same letters in a column are not significantly different

Table IV. Effect of storage on chemical composition of composite flours

Days	Moisture	Protein	Fat	Fiber	Ash	NFE	Acidity	POV	Phytic acid
0	10.93c	13.72 a	1.65 a	2.06	1.45	81.12	0.19c	0.53c	0.67a
30	11.43b	13.37 b	1.61 ab	2.05	1.44	81.52	0.25b	0.74b	0.63ab
60	12.14a	13.26 b	1.56 b	2.04	1.44	81.71	0.31a	0.99a	0.59b

Mean values for treatments carrying same letters in a column are not significantly different

There was a significant decrease in protein content during storage. At 0 day, the mean values for protein content were 13.72%, which decreased significantly to 13.37% and 13.26% after 30 and 60 days storage, respectively. This decrease in protein content in the commercial flour and remaining samples was due to the absorption of moisture from the atmosphere that further accelerated the proteolytic activity. Leelavathi *et al.* (1984) reported 2 to 2.5 times higher proteases and lipases activities in the resultant *atta* (commercial flour) than *atta*.

Data showed a significant decrease in fat content of composite flours after every storage interval. The means for fat content were 1.65% at 0 day which decreased to 1.61% and 1.56 % after 30 and 60 days storage, respectively (Table IV). At 0 day, fat content varies from 1.45-1.94%, which decreased to 1.34 to 1.90% after 60 days of storage. Farooq (1999) also reported 1.81% fat content in whole wheat flour, which was higher than white flour. This decrease in fat contents is attributed due to the development of rancidity as reported by Leelavathi *et al* (1984). Free fatty acid contents increase with storage due to the higher activity of lipase and lipoxidase which accelerates the release of free fatty acids. At moisture contents greater than 12%, risk of fat oxidation and development of rancidity increases as compared to flour containing lower levels of moisture i.e. 7.5% (Kent and Evers, 1994). Water content influenced the storage stability of wheat flour (Pyler, 1971).

As reported by Anjum *et al.* (2003) for commercial (unfortified) and fortified flour samples, storage had no effect on fiber content during 60 days storage period (Table IV). Ash content showed no significant effect of storage in different composite flour samples. At 0 day the ash content was 1.45% with a non significant difference 1.44% at the end of storage. The significant results regarding treatments were due to significant changes in crude protein and crude fat content during storage of different flour samples.

Storage had significant effect on acidity of various treatments of composite flours and ranged from 0.19 to 0.31% from start to the end of study (Table 1V). Minimum mean value for acidity (0.19%) was observed at 0 days; whereas, an increasing trend was observed with progressive increase of storage period. At 30 days it was 0.25% that increased to 0.31% at 60 days. Anjum *et al.* (2003) also reported significant increase in acidity for flour samples as a function of 3 months storage. A declining trend in acidity was observed by lowering moisture contents of stored *atta* (Leelavathi *et al.*, 1984). In the present research moisture content was increased in the flour samples with the passage of time, this may be one of the reasons for increase in acidity during 2 months storage. The rise in acidity may also be assigned to the accumulation of linoleic acids during storage which are oxidized later (Kent & Evers, 1994).

An increase in peroxide value (POV) during 60 days storage was due to development of rancidity. The means for peroxide value (Table IV) showed that this parameter increased from 0.53 to 0.99 mEq per kg during 60 days storage. In fresh composite flour samples POV was found to be 0.53 mEq per kg, which increased to 0.74 and 0.99 after 30 and 60 days storage, respectively. Higher temperature of the storage room, heat and light are the key factors that further accelerate the reactions promoting increase in acidity. At moisture content greater than 12%, risk of fat oxidation and development of rancidity increases (Kent & Evers, 1994). The reduction in phytic acid contents ranged from 0.63 to 0.67% during 60 days storage. The reduction in phytic acid contents was due to the hot and humid conditions persisting during storage, phytase activity or reaction with other food components such as proteins and carbohydrates (Misfa *et al.*, 2000). Phytic acid was subsequently decreased in iron fortified flour samples from 0.88 to 0.79% during 90 days storage (Anjum *et al.,* 2003).

CONCLUSION

The addition of lentil, chickpea and guar gum in commercial wheat flour as well as storage period significantly affected the chemical composition of composite flours. By compositing various flours (lentil, chickpea and guar gum) decrease in phytic acid content was observed, whereas storage significantly reduced the phytic acid content of flour samples. This reduction was due to hot and humid conditions persistent during storage, phytase activity or reaction with other food components such as proteins and carbohydrates. The increase in POV noted in this study was due to development of rancidity.

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