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Determination of Iron in Different Types of Wheat Flours

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ABSTRACT

This study for determination of levels of iron was carried out in different varieties as well as various types of wheat flours using spectrophotometric technique. The instrument was calibrated with standard Fe solutions. Maximum value of Fe contents (4.91-3.6mg/100g) was found in whole plain flour, grinded in the laboratory of local wheat varieties followed by chakki (motor driven small mill) flour (range 3.1-3.5mg/100g). While general trend showed that higher concentrations of Fe were found in brown followed by fine and then in super. Since wheat flour is considered the ideal fortification vehicle, a fortified Fe (60 mg/100g) flour sample was also analyzed. Keeping in mind their importance, in addition to Fe contents, per cent moisture and ash levels were also determined in these samples. The data revealed that whole grain and chakki flour have minimum moisture contents while moisture contents increased from brown to super. Similarly, whole flour and chakki flour contained high levels of ash contents. The results have been compared with the reported values of literature, which are comparable and hence, confirmed the successful application of the procedure.

Key Words: Iron; Wheat; Flour; Spectrophotometry; Anemia

INTRODUCTION

In Pakistan, most of the population is facing serious deficiency of Fe. In the past the main strategy to control Iron Deficiency Anemia (IDA) in pregnant women had been via supplementation. Realizing the low acceptance of iron tablets by pregnant women and the very limited impact of this strategy, the Government of Pakistan (GoP) in its Ninth Five Year plan (Anonymous, 1999) had promoted the control of this nutritional problem through a mixture of strategies, i.e., fortification, supplementation and food diversification. It has been suggested by GoP to initiate programme of fortifying wheat flour with iron. Before recommending Atta as the best choice for iron fortification, it has decided by (GoP) to plan a national project in order to test the feasibility and efficacy of iron fortification in wheat flour 'Atta'. Ahmad and Bilal (2001) summarizes information regarding various fortificants that are being used for the control of IDA world over along with some information on a variety of foods that have been used for iron fortification ranging from flours to spices and liquids. Wheat *(Triticum aestivum L.*) is the most important staple food crop. It is a major source of food for large section of population of the world and is supplying about 73% of the calories and protein of the average diet (Heyne, 1987). Flour is used as a recipe ingredient in many baked products (Bamidele & Nwanya, 2001). With regard to iron fortification, wheat flour (Atta) is by all means the ideal food because it is commonly consumed, in the country.

Various physical and chemical properties of Fe can be used for its qualitative as well as quantitative analysis. Many methods i.e. gravimetric, titration, atomic absorption spectrophotometry, instrumental neutron activation analysis, UV/Vis-spectrophotometry etc. are available for the determination of Fe in different papers and reports. Clearly the selection of a method for the determination of Fe is mainly dependent on the concentration in the samples, the location of the samples, the availability and cost of facilities and the type of information required. In the literature, classical and chemical methods are described in early work on Fe for its determination while more recently physical and instrumental techniques have become available and proved to be suitable for the analysis of Fe (Kirkpatrick & Coffin, 1974). The advantages of using spectrophotometry or colorimetry are its ease of sample preparation, good sensitivity and/or low detection limits, reproducibility and accuracy. Economically, it is relatively inexpensive.

So far, systematic studies for Fe determination in flour samples have not been conducted. In view of the growing realization of the importance of iron in nutrition, an initial study was conducted to measure the prevailing concentration levels of Fe along with per cent moisture and ash contents in different flour samples.

MATERIALS AND METHODS

Sample collection and preparation. Different types of flour samples were collected/procured from different sources. Depending on the quality of particle size, three types of flour are sold in the market i.e. brown (course), fine and super (maida). Details addresses and type of each sample are given in Table I. The whole-wheat grains were chopped and ground. The representative samples of all flours were mixed properly. Moisture and ash contents were determined by standard methods (Ranganna, 1978; James, 1995).

Moisture determination. The wheat flour samples (5 g each) were heated at 100^0C in an oven. The moisture contents were estimated by measuring the weight loss due to evaporation.

Ash determination. The samples were burnt at 550^0C in an electric furnace. Total ash was determined by weight of residue after incineration.

Iron determination. For Fe assays, wet digestion of these samples was done using the modified method of O'Dell *et al.* (1972) in acid mixture of H_2SO_4, $HClO_4$ and HNO_3 in ratio of 1:2:3 for further analysis. Iron was determined in ferric state (Fe^{3+}) as red brown complex formed with thiocynate ion in aqueous solution. An oxidizing agent (H_2O_2) was added. Stock solution of Fe (1000 ppm) was prepared by dissolving $FeCl_3$ in water. Standard calibration curve of 5, 10, 15, 20, and 25 ppm was drawn against absorbance at 480 nm.

Instrumentation. Iron was estimated by Shimadzu UV-160 spectrophotometer, installed at NIFA.

RESULTS AND DISCUSSION

The data related to amount of iron, moisture and ash contents in seventeen flour samples of wheat have been presented in Table I. It can be seen that the whole flour sample of Fakkr-e-Sarhad wheat variety exhibited maximum Fe values of 4.9 mg/100 g followed by Inqilab wheat variety e.g. 3.6 mg/100 g. The range of Fe contents varied between 1.6 to 3.5 mg/100 g. The Fe contents were in the range of 2.4-2.6, 2.3—2.4 and 1.6-2.3 mg/100 g in brown, fine and super flour respectively. It has been found that marketed mill flour contained he lower values of iron indicating deficiency of the element. It can be explained that minerals are always found in the grains especially in the germ and outer layer of the kernel and milling process is responsible to remove the germ and most of the outer layer of the kernel produces white flour which has a higher proportion of starch and higher caloric value than the whole wheat flour and much of the vitamin and mineral contents of the kernel are always lost in milling white flours (Stewart & Amerine, 1982). The standard level of iron in wheat flour is 3.3 mg/100 g. Hence, our findings are in agreement to the studies reported earlier (Watt & Merril, 1975).

A good quality of wheat flour like flour of Fakhr-e-Sarhad variety contained iron contents of 4.9 mg/100 g (Table I) suggest that an intake of 300 g whole wheat flour/day/person can take about 12.7 mg/day of Fe with respect to the daily intake of 14-28 mg/day recommended (WHO, 1973) as well as 18 mg/day recommended by RDA (Liu & Chung, 1972; RDNI, 1975) is comparable. It is almost established that poor growth in children results not only from deficiency of protein and energy but also from inadequate intake of vital minerals including Fe. Many factors such as body size, weight and ability to with stand stress intelligence and production can be used as indicators of good health and the nutritional inadequacy. Pakistan especially the province of NWFP has a peculiar geography beset with problems like poverty, ignorance, illiteracy, overcrowding and overpopulation. All these factors aggravate the problems of malnutrition and create a different and complicated situation. Anemia is not a dramatic illness, yet the overall effect is a general decline in performance, both physical and mental. If widespread it will result in reduced efficiency and output of the workforce of the region or nation. Among the three techniques (supplementation, fortification and food modification) used to overcome the deficiency problem, fortification is easily adopted for all classes of life. It is worth noting here that, iron can be added to flour, bread and pasta products.

In order to evaluate recovery and sensitivity of the method employed for the estimation of Fe contents, a 60

Table I. Levels of moisture, ash and iron contents in different flour sample

Description of sample	Type	Moisture (%)	Ash (g/100 g)	Iron (mg/100 g)
Whole plain flour (Fakhr-e-Sarhad), Peshawar	NIFA Variety	6.71	1.52	4.9
Whole plain flour (Inqilab), Nowshera	Local Variety	7.65	1.39	3.6
Jamal Flour Mills, Peshawar	Super	10.00	1.40	2.0
Rahmania Flour Mills, I-9, Islamabad	Fine	9.78	1.48	2.3
Naseer Flour Mills, G.T. Road, Gujranwala	Super	10.06	1.44	1.6
Sarhad Zain Flour Mills, Tarnab, Peshawar	Brown	10	1.51	2.5
Chaudry Flour Mills, I-9, Islamabad	Fine	11.44	1.40	2.4
-do-	Brown	13.47	1.47	2.4
Zamindar Atta, New Punjab Flour Mills, Lahore	Super	13.00	1.44	2.3
Chenab Flour Mills, Wah Garden, Rawalpindi	Super	13.42	1.37	2.3
Ijaz Flour Mills (3 Dachi Trade Mark), Nowshera Road, Charsadda	Fine	13.37	1.50	2.6
-do-	Super	13.40	1.34	2.4
Diesel Flour Chakki, Dawar Khan Machine, Taru, Nowshera	Plain	5.80	1.49	3.1
Diesel Flour Chakki, Fazal Subhan Machine, Taru, Nowshera	Plain	8.00	1.55	3.2
Tarnab Water Chakki, Tarnab Village, Peshawar	Local Variety-1	8.42	1.50	3.5
-do-	Local Variety-2	7.90	1.60	3.2
Riaz Flour Mills G.T. Road, Gujarat		11.46	1.37	2.6
Fortified Flour (60 ppm), Islamabad		9.03	1.76	7.50
Standard Average		**12.00**	**1.70**	**3.30**

ppm iron fortified flour sample, obtained from PINSTECH, Islamabad was also analyzed spectrophotometrically at 480 nm using Shimadzu UV-160 spectrophotometer.

The method is based on the determination of ferric state (Fe^{+3}) as red brown complex formed with colorimetric reagent i.e. thiocynate ion in aqueous solution and is specially used for the determination of semi-micro, micro and traces of substances present with great accuracy in different fields. In this pretext of low-level detection and availability of the instrument, spectrophotometric method has been employed. The method involved wet digestion of weighed amount of the sample material, chemical isolation and concentration, purification of iron to remove interferences and final determination at 480 nm using Shimadzu Spectrophotometer. The background, limit of detection and the stability of the instrument were checked each time whenever analysis was carried out. Blank samples were also run to check the background levels in the mass region of interest. The limit of detection was 0.05 mg/100 g.

The data showed in Table I indicated that the moisture (%) was minimum in the whole grains and chakki flour while the general order of marketed flour was that brown flour has lower levels of moisture followed by fine. Accurate measurement of moisture content is very difficult. Water in food items exists in three different forms i.e. bound form (water of crystallization or as hydrate), adsorbed water (physically bound as a monolayer to the surface of the food constituents) and bulk or free water (separate constituents). The free water is loss by evaporation. The maximum allowed moisture level is 12%. Moisture values include other volatile matter such as essential oils, traces of volatile acids and amines. Moisture flour >13% is liable to attack by microorganisms, mites and insects. Highest moisture content is mainly responsible for microbial spoilage and hence we can't store flour for long time. Hence from the standpoint of moisture contents the flours were of good quality having values well below the maximum limit (Watt & Merrill, 1975). It was also found that the whole plain/chakki flour contained the higher amounts of ash contents which indicates that whole chakki flour were best in comparison to the marketed flours. The super flour had found maximum moisture contents. Among commercial marketed flours, brown flour contained higher content of ash and the ash detection was the weight of residue after incineration and indicates the quality of minerals and the trace elements in the sample (Watt & Merrill, 1975).

CONCLUSIONS

It is concluded that chakki flour contains high levels of ash and iron while low moisture contents. In the marketed flours, brown flour should be preferred that contain high levels of Fe and low levels of moisture. It is suggested that a systematic survey to evaluate our existing wheat varieties and their by-products including flour be made to estimate Fe contents before launching any iron fortification of wheat at the national level. The reported standardized technique for Fe estimation will be accurate and reproducible.

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