Plant Archives Vol. 20, Supplement 2, 2020 pp. 832-835 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

IRON CONCENTRATION IN DIFFERENT BREAD CONSUMED IN SULAYMANIYAH PROVINCE, IRAQI KURDISTAN

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Abstract

Iron (Fe) is a vital element for the reserves of satisfactory health for all living organisms. It's needed by the human and animal body for the activity of several enzymes for daily energy and proteins. Bread is one of several sources for Fe. In Iraqi Kurdistan, bread is a staple food which gives the most calories and protein of daily intake compared with other countries. Kurdistanian bread such as Lawasha, Mashini, Samoon, Hawrami, and Tiry mostly are made from high extracted white flour. For determining the concentration of Fe in flour and bread samples, 50 flour and bread samples were collected in Sulaymaniyah city in 2017 and analyzed by ICP-MS for Fe metal. The average and standard deviation of Fe content in Lawasha, Mashini, Samoon, Hawrami and tiry in (mg kg^{-1}) were 13.0±5.71, 11.3±3.03, 10.0±3.25, 21.5±9.08 and 18.3±6.46 for flours and 17.0±8.31, 13.2±3.18, 18.2±7.68, 20.5±5.59 and 26.2±8.24 for bread respectively. Estimated intake based on 300g bread consumption is 5.70±1.96 mg per person per day. Overall, the results indicate that bread is a good source of Fe and they can supply most daily requirements of Fe for preventing Fe deficiency in the Kurdistan population. However, the presence of Phytic acid and some of the inhibitors may play a negative role in Fe bioavailability and the intake amount.
***Keywords*:** Iron, concentration, bioavailability, flour, Bread, daily intake

Introduction

Iron deficiency is one of several widespread nutritional insufficiencies for about two million anemia's cases worldwide (Rodriguez-Ramiro *et al.*, 2017) and affects 1.5- to 2.0 billion peoples globally (Ahmed *et al.*, 2014). Its deficiency is one of the most international health problems essentially for the pregnant women (Hoppe *et al.*, 2019). It is one of several vital micronutrients challenging humanity (Vignola *et al.*, 2016), which can control reduced immunity, raised child death, the hazard of maternal and reformed cognitive function. According to the National Nutrition Survey from 2001 to 2012 has presented that about 29% of children below age fife and 48.7% of mothers were Fe defective (Ahmed *et al.*, 2014).

The recommended daily intake (RDI) of Fe in (mg d^{-1}) is 8 for children between 0.5-5 age, 9 for children between 6-9 years, 11 for boys between 10-17 years and 10-13 for girls ages, 15 for women of childbearing and 14-17 years old girls and 9 for men and women (Domellof *et al.,* 2013). The amount of minerals that are available to absorb is more important than intake, this is to preserve mineral balance. Thus, the amount of Fe intake should be more than (RDI); this is to ensure absorbing enough Fe. Moreover, the insufficient nutritious quality of the agricultural products is the main cause for human micronutrient deficiencies, extremely in developing countries such as Iraq where products from cereal crops such as wheat are staple (Welch and Graham, 2004). Separately from the essentially low bioavailability and the concentration of Fe in wheat grain, concentrations of Fe mineral, more reduced in powdering (Zhang *et al.*, 2010) which is about 1-5 mg kg^{-1} in cereal grains including bread wheat (Frontela *et al.*, 2011).

Bread is one of several widespread foods all over the world that provides a high quantity of daily energy and proteins (Didar, 2011). It is a staple food in developing countries including Iraq, which supplies more than 90% of daily calorie intake (Turksoy *et al.*, 2010). However, in the Middle East absence of Fe is found due to intake of bread made from high extraction flours (Tavajjoh *et al.*, 2011). This bread contain high quantity of unattractive complexes such as Phytic acid, which is reduce bioavailability of micronutrients (Sedaghati *et al.*, 2011) due to its chelating properties (Frontela *et al.*, 2011). And also, due to the high growth of population and requirements for reducing the time of bread preparation; most bakeries don't use yeast and reduce the time of fermentation. This is causes bread preparation with a high concentration of Phytic acid (Tavajjoh *et al.*, 2011). Moreover, in plants Phytic acid is presents in inorganic non-haem iron form which is less bioavailable than haem form from animal sources (Rodriguez-Ramiro *et al.*, 2017). These factors cause a decrease in the amount of absorbed Fe in bread-based food.

Flatbreads are common Kurdistanian bread such as Lawasha, are made from high extraction rate flour; therefore, procurement flatbreads with high Fe content have created the need for successful technique. According to Eagling *et al.* (2014) there is high deference of Fe bioavailability between white bread and whole grain bread prepared from commercial wheat cultivars due to change in element concentration. At this time, there is a lack of data about the bioavailability of Fe in bread consumed in Sulaymaniyah province. Thus, the aims of this present study were to determine (i) the concentration of Fe mineral in flour and bread, (ii) bioavailability of Fe in flatbreads consumed in Sulaimanyah province and (iii) factors affecting Fe bioavailability.

Materials and Methods

Sample collection

Sulaymaniyah city has a high population intensive in the Kurdistan region. There are many bakeries that supply bread needed by people. These bakeries produce different types of bread such as Lawasha, Mashini, Samoon, Hawrami, and Tiry. In 2017, 50 samples of various flour and bread were collected from bakeries using simple systematic random sampling. All bread samples were completely dried at room temperature for 3 days and then powdered using a stainless steel electric mixer. Approximately, 5 g of flour and bread samples were stored in separate plastic bags labeled and transported to the University of Nottingham, the UK for further analysis.

Iron measurement

About 0.2 g of milled flour and bread samples were digested under microwave heating (Anton Parr, Multiwave 3000) for about 45 mins at 2 MPa in 4.0 mL of 68% TAG HNO_3 and 2mL H_2O_2 for grains. Digested samples were diluted to 20 mL with Milli-Q water and stored at room temperature. In the solution iron was measured by ICP-MS (Thermo Fisher scientific ICAP Q, Germany), following the procedure of Arnold *et al.* (2010).

Statistical analysis

The iron measurement of samples was done in triplicate. Data were analyzed by analysis of variance (ANOVA) or by least of Significant Difference (LSD), using the SPSS program. The significant level considered when $p<0.05$.

Results and Discussion

Iron concentration

Among the fifty samples analyzed, the Fe content ranged the highest (21.5±9.08 and 26.2±8.24mg kg^{-1}) in Hawrami flour and Tiry bread respectively, which showed to be significant ($p<0.05$), higher than all the other flour and bread samples (Table 3.1). Tiry, being a good source for iron was used in the designated limit. Hawrami flour had the highest concentrations of Fe in the fife group of flour samples followed by Tiry, Lawasha, Mashini, and Samoon. But, Tiry bread had the highest Fe concentration than other bread samples, followed by Hawrami, Samoon, lawasha, and Mashini. The results indicate that Fe concentration in flour and bread samples is higher than the permissible level of 2.5 to 5.0 mg kg^{-1} depending on foodstuff (Feyzi *et al.*, 2017). However, human critical toxicity of iron metal consumed from common dietary supply has not been informed. Furthermore, in the present study, the concentration Fe in bread samples was shown to be higher than for locally bread samples (2.28-2.82) mg kg^{-1} reported by Al-Kamil (2011) who studied trace metal concentration in locally bread samples collected in Basra city, Iraq. The difference may be due to wheat variety, environmental condition of wheat flour growing and addition of fermentation substance.

Table 1: The average iron concentration and standard deviation (mg kg^{-1}) in flour and bread samples collected at seven locations in Sulaimanyah province, Iraqi Kurdistan

Bread	Average ±SD	
Type	Flour	Bread
Lawasha	13.0±5.71	17.0±8.31
Mashin	11.3±3.03	13.2±3.18
Samoon	10.0±3.25	18.2±7.68
Hawrami	21.5±9.08	20.5±5.59
Tiry	18.3±6.46	26.2±8.24

The results also show that there is difference in the Fe concentration between flour and bread samples and increased after baking process. Natural gas has been used for producing all bread samples. Meanwhile, fuel used in bread manufacture has one source; it does not affect Fe concentration. While flour samples in bread production have various origins and different Fe concentration, it is extremely expected that the difference in Fe concentrations is due to cereal growth environment and wheat flour type before baking. According to Fe concentration in flour and bread samples can find that the baking process increased the Fe concentration in Kurdistanian bread. Samoon bread has the highest increases of 44.6%, followed by 30.03% for Tiry, 23.2% for Lawasha and 14.5% for Mashini, but in Hawrami bread Fe concentration was decreased. This is maybe due to Fe contamination through the processing of initial and next desired products due to corrosion of metallic equipment in bakeries especially for Samoon production, bakeries use ovens and equipment which are produced of Fe metal. The same result for zinc contained in Iranian bread reported by (Khanik, 2005) which Zn increased after baking. And also, Jambrec *et al.* (2016) reported that the cooking process increased the Fe content of extracted flour by 10%. Magomya *et al.* (2013) found that variation in the metal concentration in bread is related to contamination of wheat flour and bread during baking process due to the addition of water, soda yeast and salt and also contact with the used machine metal surface.

The Fe concentration of Kurdistanian bread has been compared with other countries (Table 2). The assessment showed that the Fe concentration in the current study is the same for Fe concentration in bread consumed in Sri Lanka, but less than for Poland and Pakistan. Moreover, the results mostly show that the concentration of Fe in kurdistanian bread match positively with Fe levels in bread from other parts of the world.

Table 2: Comparison of iron concentration in bread from several countries

Country	Fe ($mgkg^{-1}$)	Reference
Current study	13.2-26.2	
France	13.0-16.2	Helou *et al.* (2016)
Sri Lanka	21.2-26.2	Karunaratne *et al.* (2008)
Poland	41.0-47.0	Khouzam *et al.* (2011)
Pakistan	40.0-43.2	Qazi *et al.* (2003)
Belgium	10.0-50.0	Dewettinck *et al.* (2008)

The average per-capita dose of consumption for adults was set at 300 g d^{-1} (FAO Database, 2011) for developing countries in which vegetables and cereal are a staple food. The estimated daily intake of Fe was calculated for bread as a single daily diet in 300 g bread as shown in (Table 3). The highest intake was observed in Tiry bread and lowest in Mashini bread. This difference may be due to some factors such as flour source, extraction rate, and baking process. The intake of Fe from kurdistanian bread is less recommended dietary allowance of 15 and 10 mg for women ages 15 to 50 years and men according to (Whittaker *et al.*, 2001). It is practically recognized that reduced growth in children outcomes not simply from the absence of protein and energy but also from insufficient consumption of essential micronutrients involving Fe. Several factors including weight, body size and ability to produce and stand the pressure information can be used as guides of dietary insufficiency and reliable health. In consideration of (Table 3), Kurdistanian bread can supply 5.70±1.96 mg per person day of Fe requirement in the diet when 300 g bread consumed. Therefore, Fe availability in kurdistanian bread is low due to low content of Fe concentration in bread consumed by Kurdistan population. This is may be due to presence low amount of Fe in wheat grain grown in Kurdistan region which the soils are calcareous and contain low amount of available Fe. Thus, farmers of Kurdistan region should apply Fe fertilizer as foliar during wheat plant growing season.

Table 3: The average value of daily iron intake and standard deviation in bread samples collected at seven locations in Sulaymaniyah province, Iraq Kurdistan.

Type of bread	Fe intake in (300 g) (mg/person/daily)
Lawasha	5.09±2.49
Mashin	3.95±0.95
Samoon	5.45±2.30
Hawrami	6.16±1.59
Tiry	7.86±2.47
Average	5.70±1.96

Iron deficiency could arise from insufficient intake and poor availability of Fe in dietary sources such as cereals (Khanik, 2005). In food items such as wheat without knowledge of Phytic acid contents, the efficiency of Fe cannot be possibly determined. This is because of the negative effect of Phytic acid in wheat on Fe absorption (Hurrell and Egli, 2010). They reported that the molar ratio between Phytic acid and Fe content must be used to estimate the Fe absorption. The ratio must be less than 1:1 or rather less than 0.4:1 to significantly enhance Fe absorption in cereals. About 58-80% of minerals in wheat are found in aleuronic, but this part also contains about 90% of Phytic acid presents in the whole wheat grain (Khanik, 2005). Lopez *et al.* (2002) reported that in bread, Phytic acid decreases Fe solubility and inhibits absorption. The availability of Fe reduces due to the combination of Phytic acid with soluble Fe in the intestinal lemon to form an unavailable complex to absorption (Mosaddegh Mehrjardi *et al.*, 2014; Pozrl. *et al.*, 2009). Hurrell and Egli (2010) and Frontela *et al.*, (2011) reported that fermentation and heat treatment processes during bread-making process and addition of phytase can be used to reduce Phytic acid content in the bread before consumption, which has been shown to improve Fe absorption. Furthermore, Helou *et al.* (2016) reported that the baking process influences the mineral level in bread.

The regression analysis showed that Fe concentration was positively (R^2=0.91and 0.46, p<0.05) correlated with phosphorus and potassium concentrations in flours and (R^2=0.92 and 0.53, p<0.05) in bread respectively. The correlation of Fe in flour with phosphorus and potassium was more positive than Fe in bread. This is maybe due to that the concentration of Fe in bread altered during the bread-making process. The positive correlation between Fe with phosphorus and potassium may be due to that farmers in Kurdistan apply phosphorus and potassium fertilizers manually to improve yield. This increases the size of the plant and causes the increase in micronutrients absorption by the root of the plant. Furthermore, Ranade-Malvi (2011) reported a direct synergetic association of potassium on Fe concentration in plants.

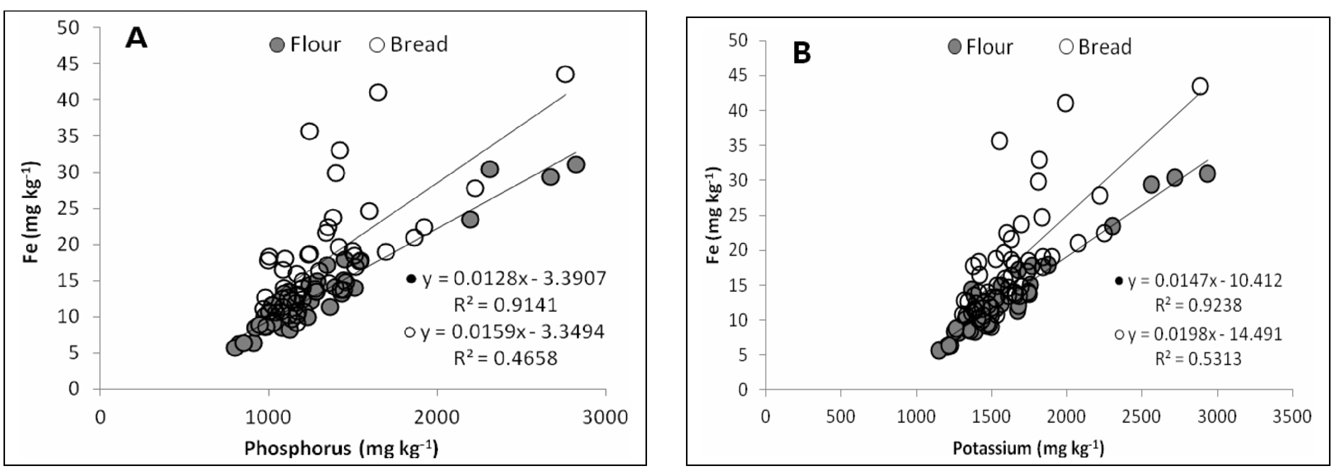

Fig. 1: Correlation between iron concentration in flour and bread samples with (**A**) phosphorus and (**B**) potassium across all the flour and bread samples (n=50) collected at different locations in Sulaimanyah province, Iraq.

Conclusion

The result of this study supplies beneficial evidence about iron contents of bread kinds produced in Sulaymaniyah province, Iraqi Kurdistan. All the fifty flour and bread samples were considered in amounts that exceed the permissible limit. Kind of baking instruments increased Fe concentration in bread. The findings of this current study suggest that the daily consumption of 300 g of Kurdistanian bread supply less than half adequate iron requirement. Additional experiments are required to assess the influence of Phytic acid concentration in consumed bread to determine the bioavailability of iron.

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