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The Effect of Wheat Flour Extraction Rate on Blood Glucose Response and Glycemic Index in Healthy Individuals

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Abstract--The aim of this work is to study the effect of flour extraction ratio on the Glucose index (Glycemic Index (GI) of Iraqi bread made from some kinds of wheat with different extraction ratios, which were 72 %, 90 % and 100 % for each kind and with participation of 70 healthy volunteers, their ages ranging from 22-40 years old and Body Mass Index between 22-30 kg/m². The volunteers were in good health Body Mass Index, BMI and they do not have any chronic diseases, including diabetes at the start of measurement, each participant underwent a glucose Tolerance Test (GTT), each participant took 50 gm from carbohydrates after fasting 10-12 hours, then blood samples were drawn from a finger after the time 0, 30, 60, 90, 120 minutes. The results of calculating GI values showed a significant differences at the level ($p < 0.01$) between the prepared bread from the white wheat 72% and the bread prepared from flour extract 90% and the whole extracted bread 100%. their values were for each of the total bread of 6Sham wheat, 95 Ipa, and 2 Talafaar reached 46, 47 and 37 and for white flour reached 76 and the glycemic load reached 23, 23 and 19 for 6 SHAM wheat, 95 Ipa and 2 Talafaar respectively, and for white flour was 38 coupled with the use of glucose as a standard substance. while the glycemic index reached 60, 61 and 49 for 6 SHAM bread, 95 Ipa, and 2 Talaafar respectively and the glycemic load reached 30, 31 and 24 for the bread of the aforementioned wheat kinds respectively when using white wheat bread as a standard substance .It was noted that there were a significant differences at the level ($p < 0.01$) among these values. The glycemic index for the each of 6 SHAM, 95 Ipa, and 2 Talafaar 90 extraction 54, 68 and 56 respectively and glycemic load 27, 34, and 28 for each of them respectively when using the glucose as a standard

substance. While the glycemic index reached 71, 89 and 74 for 6 SHAM bread, 95 Ipa, 2 Talafaar and glycemic load 36, 45 and 37 for the aforementioned wheat kinds respectively when using the bread of white wheat as a standard substance. The glycemic index from white bread 72% for 6 Sham wheat, 95 Ipa, and 2 Talafaar reached 73, 76 and 62 respectively and the glycemic load reached 36 , 38 and 31 for the bread of 6 Sham, 95 Ipa and 2 Talafaar respectively coupled with using the glucose as a standard substance. It was concluded that the percentage of extraction affects the glucose index of food. Eating bread prepared from whole wheat flour, whether 90 or 100% extraction, gave a low glycemic index compared to bread produced from wheat flour with an extraction rate of 72%, and therefore it is recommended to use bread prepared from flour extracted with an extraction rate of 100 % and 90% in the type 2 diabetes nutrition program.

Keywords---dietary fibers, extraction ratio, glycemic index, type 2 diabetes.

Introduction

Diabetes is one of the most common non-communicable diseases (NCD) and the severity of its epidemic put it at the forefront of health challenges that faced and confronted the societies of the world (WHO, 2021) .Diabetes is defined as a multi-cause metabolic disorder characterized by chronic hyperglycemia caused by a disturbance in metabolism of carbohydrates, fats and proteins that leads to a malfunction in the functions of most of the body's systems resulting from a defect in the secretion of insulin or its effectiveness or both of them (WHO, 2006). It is a chronic disease and a dangerous health problem and it is one of the four diseases that take precedence and priority for treatment in the world. The number of cases and its spread has increased continuously during the two last decades (IDF, 2020 and WHO, 2016).

The reasons for the rise in the spread of diabetes in the world are due to the age of society, economic development, urbanization, unhealthy and improper eating habits and sedentary lifestyles. Although the main cause is the genetic factor to develop type2 diabetes but unhealthy food and sedentary lifestyle are among the most important reasons for its spread, however a large number of cases of type 2 diabetes can be prevented by changing the lifestyle, keeping the person's normal weight and following the diet maintaining health, following up on normal physical activity, avoiding smoking and alcohol. However, pathological symptoms such as overweight and obesity, especially the pattern of central obesity in men, are the most important factors that lead to the development of the disease (Taylor, 2013 and Zheng et al 2018). Therefore, there is a need to find nutritional plans that work towards improvement or maintain a blood sugar balance close to normal and improve planned risk factors in treatment for adult patients with diabetes and those who have the first signs diabetes pre-diabetes (Evert et al 2019), in addition, the infection of type 2 diabetes can be delayed or avoided especially when the first signs appeared by undergoing an intensive medical –behavioral intervention program to achieve a loss of 7% of the initial body weight, increase

the intensity of the usual physical effort and reduce intake energy, which lead to an improvement in the metabolic indicators related to the targeted body organs and their complexities (ADA, a 2020). Jenkins et al (1981) presented the concept of glycemic index for diabetes in 1981 to determine the blood sugar response of different carbohydrates foods with the continuation of the debate and discussion about it as an important way to control the number of health problems and diabetes mellitus. GI, glycemic index is a value for describing foods on how slowly or quickly those foods raise blood sugar levels after eating them. Foods with a low glycemic index lead to the release of glucose slowly and at a constant speed, while foods that are high glycemic index lead to the release of glucose quickly (Harvard Medical School, 2020), which is a scale used to grade foods that contain carbohydrates and how they alter blood sugar levels (CDA, 2013), but using this index alone may lead may lead to the value of controlling blood sugar levels without taking into account the amount of carbohydrates in the serving size , for this reason, the Glycemic load (GL) was found, which explains the amount of grams of carbohydrates presented in each meal eaten (USDVA, 2020). Usually the index value of a standard food is 100, glucose has a response of 140% greater than the index value of white bread or the index value of white bread is equal to 71% of the glucose index (Beals, 2005) .Glycemic index (GI) values range from 55 or less, and 56 to 69 and 70 or more, these are the values that are considered Low, Medium and High respectively (Brand Miller et al 1996).

Insoluble fibers such as cellulose, hemicelluloses and lignin, which are present in foods such as wheat bran, whole grains and vegetables have a high ability to absorb water in the intestine, which increases its size to be a large, low density mass. this makes it easy to move in the intestine and helps in the normal functions of the intestine and reduces constipation and the chances of colon cancer are reduced whether due to carcinogenic chemical or due to the metabolites formed in the intestine, especially steroids and cholesterol that are secreted bile, as well as due to the increase of beneficial bacteria in the intestinal Flora and at the expense of the growth of pathogenic bacteria. As for the soluble fiber found in legumes , oats ,barley and some fruits and vegetables play a role in lowering the levels of cholesterol and other lipids in the blood and regulates the normal and balanced use of blood sugar (Uklanska and Nawirska, 2008, Bachheti and Rana, 2011). Several reports refer to the content of wheat bran, which is mainly composed of a substance non as B-glucan, a non- starch polysaccharide found in other grains such as oats and barley (Wood 2007).

B-glucan levels are influenced by both embryonic and environmental factors, although genetics appear to be more important, where the addition of B-glucan leads to low the glycemic index (GI) predictably with maintain taste in a 50-grams portion of carbohydrates .Each gram of beta –glucan reduces GIby 4 units, making it a useful functional food ingredient for reducing blood sugar after eating The Iraqi people use many types of bread. One of the most widely used is the traditional flat bread, which is made of white wheat flour, which is free of bran after removing it from the flour. This bread can be classified as a food with a high glycemic index because it is free of nutrition fibers and its carbohydrates content will affect on the ratio of blood sugar after eating. Consequently, it will raise blood sugar and insulin and stimulate fat storage (Jenkins et al. 2008)

Materials and Methods

The foodstuffs used (sources of food samples). The cultivars of wheat *triticum aestivum* L. under study, namely 6 Sham 2Talaafar and 95 Ipa were obtained from Nineveh Agriculture Directorate / Nineveh Governorate. These kinds were taken from the agriculture season 2019 -2020, they are one of the local varieties in Nineveh Governorate and dedicate to manufacture of local bread. The use of three kinds of local wheat in Nineveh Governorate which are 6 Sham, 2 Talaafar and 95 Ipa were obtained from Nineveh Agriculture Governorate. These kinds were taken from the 2019- 2020 agriculture season, where the seeds were prepared for grinding by isolating the foreign seeds and impurities from the wheat grains through a sieve with holes dimensions 2.2*20mm, then washed with plain water to remove dust and dirt and then dried by using Cabinet dryer through a hot air stream at a temperature of heat 55C for 48 hours until the seeds are completely dry. The samples obtained were kg per item, each of them was divided into two parts. The first part was used for the study and the other part was kept as a backup models to be used when needed. The samples were kept in polyethylene bags which were placed in the refrigerator at a temperature of 40Cuntil chemically analyzed. Tempering and conditioning of wheat was done, where the amount of water to be added to each kind of wheat was calculated after knowing its initial moisture. The moisture content was measured in it and ranged between 9.72- 6.49 % according to the kind used and the required water amount was added for tempering to reach a humidity of 14% by using ordinary water and according to the equation (ALSALIH ,1996).

$$Q = \frac{P(H_f - H_i)}{100 - H_f}$$

Where:

Q = amount of water to be added (kg)

P = weight of grains (kg)

HF = final water content of the grains

Then the models were left for 24 hours with flipping the sample container every now and then to homogeneous distribution for humidity and moisture conditioning for grains The samples of grains were grinded wheat milling in Nineveh governorate and Conclusion ratio of flour extraction was calculated according to the equation mentioned above (ALSALIH 1996):

$$\text{Extraction\%} = \frac{\text{The weight of obtained flour}}{\text{The weight of seeds *weight of the added water}} \times 100$$

The extraction ratio ranged between 70-72 % for bread wheat, and then the flour samples were kept in polyethylene bag at 4Cuntil tests were conducted on them. Three kinds of flour were prepared from the aforementioned kinds of wheat, which were: Sham 6, Tal Afar 2, and Iba 95, with extraction rates of 72%, 90% and 100%. Sieves equipped with Nineveh Agriculture Directorate were used to obtain

three types of flour for each class , bread was prepared from whole wheat flour and white flour bread with an extraction ratio of 72% and bread with a replacement ratio of bran of the same type at a ratio 10% for each class , namely with extraction ratio 90% . The limited quantities in table (1) were weighted, which give 50 g of fiber- free carbohydrates. The dough was prepared as follows: 1 g of yeast ,1.5g of table salt and approximately 50 ml of water , and after period of fermentation shaping and preparing according to the conventional method in the bread industry (SULAKA, 1990). The dough was backed at a temperature of 180 C for 9-10 minute, then the bread was cooled to room temperature after that the bread samples were kept in polyethylene bags in the freezer until consumption and the biological selection procedure. A number of bread samples were prepared according to the number of volunteers and the tests that were conducted.

Chemical analysis

The chemical analysis of raw and prepared (backed) primary foodstuffs was done in the Department of Food Sciences and the Central Laboratory at the college of Agriculture and Forestry, University of Mosul as shown below:

- **Moisture Determination.**
The moisture of raw and the backed materials was estimated by using a rapid moisture tester device supplied by the German Company (Brabender) at a temperature of 105C until the weight was stable according to the AOAC method (2005) . Where the moisture in the raw and backed materials was estimated , and in both cases , the amount of moisture absorbed by the product was calculated in order to calculate the amount provided to the donor , which contains 50g of carbohydrates.
- **Crude fat Determination**
The ratio of fat was estimated by following Soxhlet Extraction Units by using Petroleum Ether with a boiling point of 60- 80 C until the complete extraction of the fat from the samples was ascertained by repeating the Siphoning process several times, based on the method mentioned in AOAC (2005).
- **Protein Determination**
The protein was estimated by using the (Micro kjeldehl) method and using Distiller " DNP-1500 -MP " Protein -nitrogen depending on a conversion factor 5.7 Factor to obtain the ratio of protein in the sample according to the AOAC method (2005) and AACC method (2000).
- **Ash Determination:**
Ash was estimated by using the burning of the raw material by using (Muffle furnace) type burning furnace is Nabertherm Compact Muffle Furnace LE 6/11/B150 LE06OKIBN at a temperature 550C until the weight is stable and the ash becomes white with a slight grayish appearance according to the method mentioned in AOAC (2005).
- **Crude Fiber Determination**
Crude fibers were estimated according to the method mentioned in AOAC (2005) by using acid and base digestion , the digestion product was incinerated with some modifications , where oil or fat was extracted by using extraction units Soxhelt Extraction by using Petroleum Ether with a boiling point of 60-80 C mentioned previously as much as possible from the

weight of 100g of the sample, then the remaining of the sample was transferred quantitatively to a gradual conical flask with a capacity one liter, then 125 ml of hydrochloric acid (HCL) with 5% concentration was added, then the volume was completed to 500 ml, then the digestion process happened for half an hour from the start of boiling. The components were filtered by Buchner funnel and Whatman 40 filter papers and washed several times with hot distilled water to get rid of traces of acid, then it was returned to the beaker and 125 ml of NaOH with concentration 5% was added, then the volume was completed to 500 ml, then the digestion process was also conducted for half an hour from the beginning of the boiling. The filtration was done by using a Buechner funnel and Whatman40 filter papers, then washed several times with hot distilled water to get rid of the traces of the base, after that the PH was adjusted to 7-6.5, then the material was dried at a temperature of 40 C in a vacuum dryer for 12 hours, and the weight was calculated and the proportion of the total crude fibers was calculated.

- Carbohydrate Determination

The carbohydrate ratio of foods was calculated by subtracting the total of the estimated components (moisture, ash, fat, protein and crude fibers) from the number 100, so the result is the percentage of carbohydrates in the food (DALALI and AL-HAKEEM 1987).

Determination of Glycemic Index (GI)

The Glycemic index of foods used in the experiment was measured according to the method found by Jenkins et al (1981) and this method is methodology recommended by world Health Organization (WHO/ FAO, 1997) with participation of 70 healthy subjects volunteers from primary and postgraduate students and the employees at the University of Mosul in the College of Agriculture and Forestry, Department of Food Sciences, their ages ranged from 22-40 years and Body Mass Index (BMI) between 22-30 kg/m² and the volunteers were enjoying good health without any chronic diseases including Diabetes. The above volunteers were divided into groups, and each group consisted of three to four people, some of them underwent to GI measurement for one sample of samples and the stander diet (Glucose). The examination was conducted every morning after the volunteer was subjected to a fasting period of not less than 12 hours and not more than 14 hours. The examination was usually done in the early morning before breakfast. Blood glucose was measured at the fasting level and before lunch (Time zero) by taking blood samples from the finger prick capillary of the participants, the glucose ratio was measured in these samples taken directly and blood glucose test strips manufactured by Chec TM Ino Viva German Company were used. After that the examination was conducted as follows:

Two blood samples were taken from the fasting volunteers whom their number was determined to do the examination for a specific food before eating food as it represent the beginning of the basal line. The meal of food was given to determine its Glycemic Index which contains 50 g of available carbohydrates, it usually takes a short time for eating food such as drinking fluids to about 10 minutes at the maximum. Then blood samples were taken for examination after fasting at

intervals 30, 60, 90, 120 minutes after the participants ate the measure food in order to estimate glucose concentration.

Blood Glucose Response (BGR)

It is a translation or explanation of the blood glucose concentration level scale with the required time to do the examination into graphical information and graphic form, then estimating the area below the product graph and comparing it to a standard material Incremental Area Under 2h blood glucose Curve (IAUC) that is glucose and white bread. The area under the curve was calculated in a mathematical way by using the statistical computer program called GraphPad Prism 8.4.3.686 by GraphPad Company and Excel program was also used, which was pre-prepared to calculate Glycemic Index (GI) and Glycemic Load (GL). The Glycemic Index for each food was calculated by calculating the increase in area under the response curve of blood glucose for two hours for each tested food and the area under the response curve of blood glucose for the same period of standard food, the glucose and white bread. According the Glycemic Index (GI) by the following equation:

$$GI = \frac{\text{Incremental area under 2h blood glucose curve for food}}{\text{Incremental area under 2h blood glucose curve for glucose}} \times 100$$

The GI classification used by Brand – Miller et al. (1996) and Foster – Powell et al. (2003) has been adopted, when it is less than <55, it is low and from 56-69, it is medium and more than >70, it is high. According to Glycemic Load (GL) as follows:

- Glycemic Load (GL) = Glycemic Index (GI) / 100 x Total Carbohydrates in Per serving
- Glycemic Load (GL) = Glycemic Index (GI) / 100 x Net Carbohydrates
- Net Carbohydrates = Total Carbohydrates – Fiber per serving

Statistical Analysis

Statistical analysis was conducted by using Social Program Statistics System (SPSS) program according to analyze the variance ANOVA. The arithmetic averages were compared and the differences among the groups were determined by using Duncan's Multiple Test (Hussein, 2021; Duncan, 1955).

Results and Discussion

It is noted from Table (1) that the content of white wheat flour differs from that of flour of 90% extraction and 100% extraction flour in terms of chemical components. All types of flour followed by Ipa 95 flour 12.7% and 10.76% flour of Talafar 2 variety, respectively. The results showed significant differences in the mean values of flour moisture for the studied wheat varieties at the level (P <0.01) due to the conditioning process of wheat that was conducted on wheat grains before milling in order to improve the physical state of the grains intended for

milling and to improve the properties of the resulting flour (Vinogradov et al. (2021).

The percentage of fat in the flour was 72%, extracting 1.49%, 1.46% and 1.26% for the varieties Sham 6, Ipa 95 and Talafar 2, respectively. As for the varieties with a 90% extraction rate, the percentage of fat reached 2.13%, 1.89% and 1.80% for the wheat varieties Ipa 95 Sham 6 and Talafar 2, respectively, while the percentage of fat in fully extracted flour was 100% for the varieties Ipa 95, Talafar 2, and Sham 6 2.31%, 2.20% and 2.08%, respectively. From these results, a decrease in the percentage of fat in flour is observed than it was in whole grains and this it is due to the milling and sieving process, which led to the removal of a different percentage of the bran, embryo, and the outer endosperm, which contains a high percentage of protein, minerals, vitamins and fat. Wheat bran contains 5.5-5.6% fat, and wheat germ is about 28.5% fat, and most of these fats are phosphorous phospholipids and some glycolipids in the bran, and 50% of the fats are unsaturated lipids with 18 carbon atoms and two double bonds Babu et al. (2018).

As for the protein content, the protein content of flour samples reached 72%, 11.45%, 11.28%, and 9.36% for the varieties Talafar 2, Sham 6, and Ipa 95, respectively, while the protein content of the flour samples reached 90%, for the varieties Talafar 2, Sham 6, and Ipa 95 were 12.24% and 11.91%. And 10.58%, respectively. As for the extracted whole flour 100%, its protein content reached 13.24%, 11.72% and 11.59% for the varieties Talafar 2, Sham 6 and Ipa 95, respectively. The results also showed significant differences at the level ($P < 0.01$) between the average values of protein values for the studied wheat varieties, where The protein content of wheat flour ranges from 6-18% depending on the type or class of milled wheat, growing conditions, and fertilizer inputs, especially nitrogenous. The quality of flour proteins is determined by the levels and distribution of protein fractions mainly gluten, gliadin and glutenin which It varies with different types of wheat and their growing conditions as well as processing methods mainly milling (Carson and Edwards, 2009).

The percentage of ash in the studied varieties with an extraction rate of 72% is 0.73%, 0.72% and 0.65% for the flour of Talafar 2, Sham 6 and Ipa 95, respectively, while the percentage of ash in the flour of Talafar 2, Sham 6 and Ipa 95 extraction of 90% was 1.23%, 1.14% and 0.99% straight, As for the flour with an extraction rate of 100%, the ash percentage was 1.43%, 1.40% and 1.98% for the varieties Tal Afar 2, Sham 6 and Ipa 95, respectively, and through the results, the values of ash ratios for the flour of the studied wheat varieties with its three extracts showed significant differences 72%, 90% and 100%. At the level ($P < 0.01$) among them, the ash content of any flour is mainly affected by the ash content of the wheat from which it was milled, and the extraction rate of the milling (Zhao, 2016). The process of moistening the wheat before milling, the efficiency and type of the mill used, has a significant impact on the amount of ash in the flour, and increasing the amount of bran leads to an increase in its content of ash and thus in the product manufactured from it (Banu and Aprodu, 2015), as the milling process of the samples in this study was mediated by A commercial mill affiliated to one of the mills in the flour-producing governorate, the flour content of ash may differ from what is found in the flour samples produced by a typical

laboratory mill for the same extraction ratios. The results of this study agree with what was stated by researcher Czaja et al. (2020) that the ash content in Flour be in the range of 0.5-2.5%.

The results in Table (1) show the values of the proportions of raw fibers in flour with 72% extraction, which amounted to 0.42%, 0.37% and 0.36% for the varieties Talafar 2, Sham 6 and Ipa 95, respectively, while the proportions of crude fibers of 90% were 1.39%. And 1.34% and 1.05% for the varieties Talafar 2, Ipa 95 and Sham, respectively. As for the flour with full extraction rates, the percentage of fiber in it reached 2.61%, 2.04% and 2.03% for the varieties Ipa 95, Talafar 2 and Sham 6, respectively, due to the increase in the proportion of bran rich in fibers and ash (Thannoun, 2005). The percentage of carbohydrates for varieties with milling with an extraction rate of 72% reached 75.92%, 75.46% and 73.53% for the wheat of Ipa 95, Talafar 2 and Sham 6, respectively. As for the whole wheat flour, the percentage of carbohydrates reached 72.14%, 71.97% and 71.06% for the varieties Talafar 2 and Sham 6 and Ipa 95, respectively, and these results agree with what Miller (1996) and Kulp (2000) mentioned that the percentage of carbohydrates in whole wheat flour is 71.20, and its percentage in refined (unfortified) wheat flour is 76.31%. The amount of bran and germ can vary between wheat varieties. Thus, in addition to the processing conditions from the moistening and milling process, the genotype, environment and cultivation conditions can influence the different nutrient ratios of the grains. In general, (WWF) wholegrain flour contains more fibres, minerals, vitamins and bioactive compounds than refined flours made from only endosperm (Gómez et al., 2020), as the environmental and genetic factors in which the varieties are grown have a greater impact on the content of the grains of elements and pollutants. All of them (Sulaka, 1990).

Table 1
Chemical analysis of wheat flour

wheat flour	Ingredients: g/100 g					
	Moisture	Fat	Protein	Fiber	Ash	Carbohydrate*
Talafar flour 72%	10.76 bc	1.265 d	11.45 cd	0.424 e	0.73 F	75.36 a
sham flour 72%	12.66 a	1.499 cd	11.28 de	0.375 e	0.654 F	73.53 b
IPA flour 72%	12.17 a	1.461 cd	9.36 F	0.636 de	0.723 F	75.65 a
Talafar flour 90%	9.64 D	1.808 bc	12.24 bc	1.393 c	1.23 Cd	73.69 b
sham flour 90%	11.32 b	1.89 B	11.91 bcd	1.058 cd	1.148 de	72.67 bc
Ipa flour 90%	11.1 bc	2.139 ab	10.58 e	1.343 c	0.99 E	73.85 b
Talafar flour 100%	8.93 E	2.203 ab	13.24 a	2.048 b	1.434 B	72.14 cd
sham flour 100%	10.68 bc	2.088 ab	12.72 ab	2.035 b	1.406 bc	71.07 d
IPA flour 100%	10.41 c	2.317 a	11.59 cd	2.63 a	1.987 A	71.06 d

Vertically similar letters do not differ significantly at the level (P < 0.01). Carbohydrates: Calculated as a difference in ingredients

Table (2) shows the chemical composition of the whole bread produced from the whole wheat flour that is the whole wheat grains grinded, prepared from wheat flour used for three kinds of wheat and used to estimate the Glycemic Index in healthy volunteers based on its content 50 g carbohydrates. As a result of determining the amount of carbohydrates, the meal provided to the volunteers

contained brown bread for Talaafar wheat flour, 6Sham wheat flour, 95Ipa wheat flour weighing 102.13g on 9.68, 1.33, 0.76 and 1.27 grams protein, fat, raw fiber and ash respectively and the whole bread for 107, 1g sham wheat. These values are consistent with the values obtained by Al-Qabati (2003) for whole bread as well and close to the values obtained by Aziz (2015) when they rely on the standard meal of the whole bread containing 50 g of carbohydrates provided to the volunteers. when comparing the composition of bread from the whole flour of wheat kinds, it is noted that they are close in some values except for the protein ratio of flour bread of 95 Ipa wheat, which was close to the protein ratio of flour bread of 2 Talafaar.

Table 2
Composition of the whole extraction flour bread for the wheat kinds used

Kind of food	Food weight before preparing (g)	Food ingredients (g)					Weight of eaten food (g)
		Carbohydrates	Protein	Fat	Fibers	Ash	
2talafar	69.30	50	9.68	1.33	0.76	1.27	102.3
6 sham	70.35	50	9.96	1.86	1.05	2.24	107.1
95 Ieba	70.36	50	9.68	1.48	0.63	2.06	107.1

Table (3) shows the results of estimating the response of blood glucose, Glycemic Index and Load Glycemic for the three kinds of bread produced by the whole flour extracted of wheat kind used in the study coupled with the response to white bread and glucose as a standard material. Table (2) indicates that the response of blood glucose to the total bread from the used wheat flour kinds did not increase significantly, where the blood glucose concentration was gradually increased for the bread made from the whole flour extracted of 6SHAM wheat from 84.00 mg/dl in the beginning of measurement at zero time to 103.66 after 30 minutes of taking the meal and rose slightly until 60 minutes as a maximum, after that the concentration gradually decreased to 102.33 and then 88.33md/dl after the time 90 and 120 minutes. While taking bread made from the whole flour extraction for 95Ipa wheat showed a slight increase in blood glucose starting from the time zero, which the glucose response was 83.66 mg/dl to the maximum at the 60th minute that reached 121.66 after the thirty minutes in which it was 94.33, after that whereas, when consuming wheat flour of 2 Talafaar, it was observed that the blood glucose response reached 93.33 mg/dl at the 30th minute after the baseline at which it was 78.00 and reaching the maximum at the 60th minute to become 106.33 mg/dl, then the response of blood glucose was gradually decreased to become 102.66 and 96.33 mg/dl after the 90th minute and 120th minute and this was shown in figure (1), so that it was flatter when the response was slow compared to white bread and glucose, where the blood glucose concentration increased from 96.66 to the highest concentration of 109.00 and 128.33 mg/dl after 90 minutes passed from eating white bread and 30 minutes from taking standard glucose respectively table (2), after the 90th minute, the blood glucose decreased directly to the concentration of Base line in 120th minute.

Table 3
Response of blood glucose and Glycemic Index and Glycemic Load of the whole bread for healthy persons

Food type	Blood glucose response mg/dL					IAUC Mg/dl/min.	Glg	GLg	Gib	GLb
	Time / minute									
	0	30	60	90	120					
6sham	84	104	115	102	88	1746 B	46 cde	23 F	61 Cb	30 fde
95Ieba	84	94	122	106	85	1750 B	47 cd	23 F	61 Cb	31 fde
2talafr	78	93	106	103	96	1414 B	37 fd	19 fg	49 Cd	24 fe
White bread	97	109	128	113	101	2900 A	76 b	38 fde	100 A	50 cd
glucose	95	119	142	123	94	3805 A	100 a	50 cd		

The numbers represent 3-4 replicates. Vertically different letters indicate that there are significant differences at the level ($p < 0.01$). Glg and GLg Glycemic Index and Glycemic Load respectively when using Glucose a standard food. Gib and GLb Glycemic Index and Glycemic Load respectively when using white bread a standard food. (IAUC): Area under curve mlg/disleter

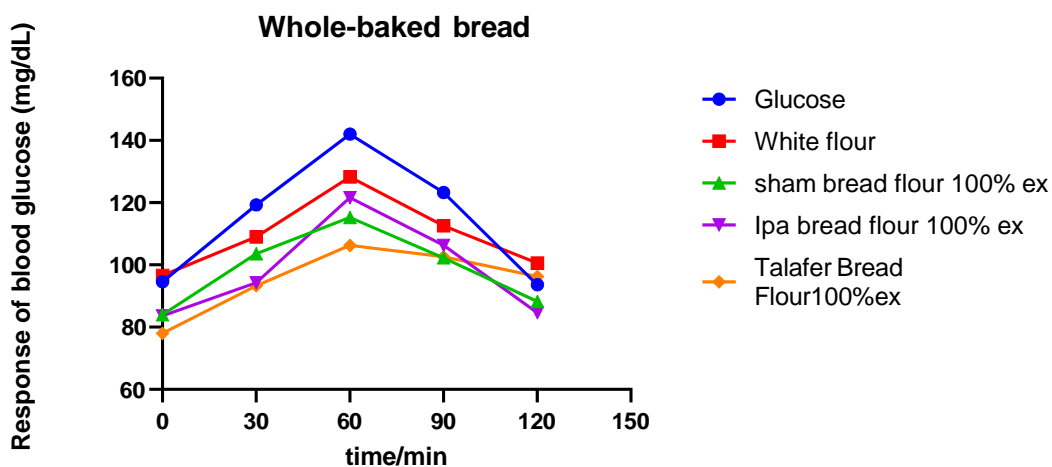


Figure 1. Blood glucose response, glycemic index and glycemic load for 100% wholemeal bread extract in healthy volunteers

In case of white bread compared to the glucose response, which gradually decreased till the concentration of Base line was reached at the 120th minute as shown in figure (1). Table (3) shows the area under the curve (IAUC) of the glycemic Index (GI) and glycemic Load (GL) for white wheat bread and the whole wheat bread of wheat flour of 6SHAM, and 2 Talafaar and 95Ipa among healthy volunteers. The area under the curve of the blood glucose response when eating the whole wheat bread of 6SHAM, 95Ipa and 2 Talafaar reached 1746, 1749.7 and 1413.5 mg/dl/min respectively compared to 3805.33 and 2900 mg/dl/minute for glucose and white bread respectively. Table (2) shows that there were a significant differences at level ($p < 0.01$) among the values, and the table indicates that the Glycemic Index for the whole bread of wheat of 6SHAM, 95Ipa and 2Talafaar reached 45.88, 46.52 and 37.14 and for white bread reached

76.21 and Glycemic Load reached 22.94, 23.26 and 18.57 for the wheat bread of 6SHAM, 95Ipa and 2Talafaar respectively and for white bread was 38.10 coupled with the use of glucose as a standard material. While the Glycemic Index reached 60.20, 61.04, and 48.74 for 6SHAM, 95Ipa and 2Talafaar, and Glycemic Load 30.10, 30.52 and 24.37 for the bread of aforementioned wheat kinds respectively, when using white wheat bread as a standard material. It was noted that there were significant differences at the level ($p < 0.01$) among these values. It was a lower result than what was found by Foster –Powell et al. (2002) and Al-Qubati and Thannoun (2005). The results also indicated that the Glycemic Index and Glycemic Load of the whole bread were also low compared to the Glycemic Index and Glycemic Load of white wheat and it was also lower than what mentioned by Foster –Powell et al. (2002), Foster –Powell and Brand –Powell (1995). The reason is due to the high ratio of raw fibers in the whole bread and this was shown by table (1) in terms of the noticeable difference among the ratio of white bread and brown bread or the whole studied kinds of bread of 6SHAM, 95Ipa and 2Talafaar respectively, it is due to the processes of humidification, grinding, extraction, sieving and sifting and separate the bran (Al-Qubati, 2003 and Thannoun, 2005).

The high ratio of fibers in food led to decrease in Glycemic Index, and this was supported by Jenkins et al. (1986) and De Schrijver et al. (1992) before that. The brown bread is characterized by being rich in dietary fibers, which are essential in the human diet, although they do not produce thermal energy, and when these dietary fibers reduced, the total period of stay of the digested food in the digestive canal of a human may be prolonged, which leads to constipation, diseases of blood vessels, hemorrhoids, intestinal disorders, colon cancer and increased of ratio cholesterol. The dietary fibers also help in reducing some diseases of the digestive canal such as diabetes. These values of the obtained GI are consistent with some studies and different with others because many factors may lead to the difference of GI of bread, such as the thickness of the bread layer, which leads to the process of gelatinization and digestion of starch and this action increases when food is exposed to conditions that increase the possibility of amylase enzyme access to starch, and the structure of the starch granule maybe broken mechanically during the milling process or by water and heat (gelatinization) (Al-Qubati, 2003). During the gelatinization process, the starch granules absorb water, swell and rupture to release the starch components from amylase and amylopectin for decomposition and the extent or degree of gelatinization depends on the provision of moisture, heat and pressure (Ai and Jane, 2015) in addition to the ability of digested the starch may be decreased by the reaction of the reverse reaction as a result of cooling the starch and turning the starch into resistant starch (Saber, 2011) as well as in the case of the non-enzymatic browning (Mallard) reaction and the degree of roasting and depends on the processing time and temperature, with the presence of moisture to reduce the presence of some materials such as sugars (Cornejo-Ramirez et al. 2018).

Table (4) shows the chemical composition of brown bread with extraction 90%, which is the wheat flour free from big bran prepared from flour used for the three kinds of wheat and used to estimate the Glycemic Index in healthy volunteers, based on its containing 50 g of carbohydrates, and as a result of determining the amount of carbohydrates, the meal presented to the volunteers from brown bread of Ipa, SHAM and Talafaar wheat flour that the amounted weight of Talafaar

bread 101,21 on 6,85,1,78, 0,89 and 0.94 g protein, fat, raw fibers and ash respectively and from the bread 90% of 6SHAM wheat flour that the amount of its weight 101.56 g contained 9.62, 1.45, 0.92, 1.17 g protein, fat, raw fibers and ash respectively. As for brown bread of Ipa wheat flour that the amount of weight of Ipa 99.82g contained 10.96, 0.60, 0.88 and 1.88 g from protein, fat, raw fibers and ash respectively. When comparing the composition of bread made from brown flour with an extraction 90% of kinds of wheat, it is noted that they are close in some values except for the ratio of protein and ash for Ipa wheat flour bread, which was the higher compared to the ratio of protein and ash for 6SHAM and 2 Talafaar flour bread.

Table 4
Bread made from flour with an extraction ratio 90% for wheat kinds

Food type	Weight of food before preparingg	Food ingredients (g) Carbo.	Protein	Fat	Fibers	Ash	Weight of eaten food (g)
2 talafar Extraction 90 %	67.85	50	6.85	1.78	0.89	0.94	101.21
6 sham extraction 90%	68.80	50	9.62	1.45	0.92	1.17	101.56
95 Ieba extraction 90%	67.70	50	10.96	0.60	0.88	1.88	99.82

Table (5) shows the results of estimating the response of blood glucose, Glycemic Index and Glycemic Load for the three kinds of bread produced from extraction flour 90% of the wheat kinds under study coupled with the response to white bread and glucose as a standard material, the table also indicates that the blood glucose response for brown bread with extraction 90% from the flour of the used wheat flour did not rise much, where the blood glucose concentration gradually increased for bread made from 6Sham, from 92 mg/dl at the beginning of measurement at time zero to 103 after 30 minutes of eating the meal and slightly increased until the 60th minute reached 118 as a maximum, then the concentration gradually decreased to 106 and then 94 mg/dl after the time 90 and 120 minutes of time. While eating bread made from wheat flour 95Ipa with ratio extraction 90%, showed a gradual rise in blood glucose, starting from the time zero, which was in response to blood glucose of 87 mg/dl to a maximum at the 60th minute, reached 126 after the 30th minute in which it was 104, then the response ratio of the wheat flour reached 2Talafaar and the response of blood glucose reached 101 mg/dl at the minute 30th after the base line in which it was 83 and reaching a maximum at the 60th minute to reach 116 mg/dl, then the response of blood glucose gradually decreased to reach 113 and 97 mg/dl after the 90th minute and 120th minute and this is what figure (2) shows, where it was more flat when the response was low compared to the white bread and standard glucose, where the blood glucose concentration increased from 97 to the highest concentration of to reach 109 and 128 mg/dl after passing 90 minutes from

eating the white bread and 30 minutes of eating standard glucose, respectively (Table 5) after the 90th minute, blood glucose directly decreased to the concentration of base line at 120th minute

Table 5
Blood glucose response and Glycemic Index and Glycemic Load of the bread 90% for healthy person

Food type	Blood glucose response					IAUC mg/dl/ min	Glig	GLg	Gib	GLb
	mg/dL									
	Time / min									
0	30	60	90	120						
6sham bread90%	92	103	118	106	94	2062 c	54 fe	27 H	71 dc	36 gh
95ieba bread90%	87	104	126	113	99	2585 cb	68 dce	34 Gh	89 ba	45 gh
2talafar bread90%	83	101	116	113	97	2138 c	56 dfe	28 h	74 c	37 gh
White bread	97	109	128	113	101	2900 b	67.2 bc	38 gh	100 a	50 gf
Glucose	95	119	142	123	94	3805 a	100 a	50 gf		

The numbers represent 3-4 replicates. Vertically different letters indicate that there are significant differences at the level ($p < 0.01$) Glg and GLg Glycemic Index and Glycemic Load respectively when using Glucose a standard food Glb and GLb Glycemic Index and Glycemic Load respectively when using white bread a standard food. (IAUC): Area under curve mlg/disleter.

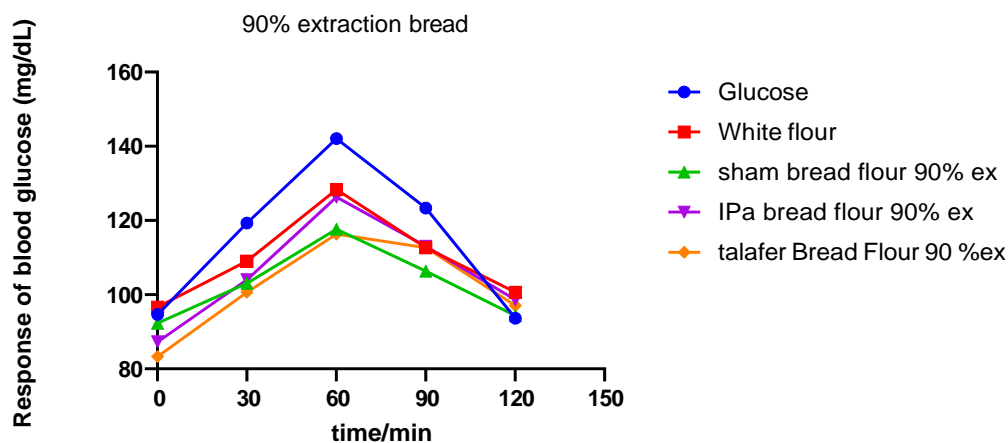


Figure 2. Response of blood glucose, glycemic index and glucose load to brown bread 90% extraction in healthy persons

Table (5) shows the area under the curve (IAIC) for Glycemic Index (GI) and Glycemic Load (GL) for white wheat bread and brown wheat bread with an extraction 90% for the flour of 6SHAM, 95Ipa, and 2Talafaar among healthy

volunteers. The area under the curve for blood glucose response was 90% when eating wheat bread for 6SHAM, 95Ipa and 2Talafaar 2062, 2585 and 2138 mg/dl/min. respectively compared to 3805 and 2900 mg/dl/min for standard glucose and white bread respectively, the table shows also that there are significant differences at the level ($p < 0.01$) among these values. The table indicates that the Glycemic Index (GI) of 6SHAM, 95 Ipa and 2Talafaar reached 54, 68, and 56 respectively and Glycemic Load (GL) 27, 34 and 28 for each of them respectively, when glucose was used a standard material while the Glycemic Index (GI) reached 71, 89 and 74 for 6SHAM, Ipa and 2Talafaar and the Glycemic Load (GL) reached 36, 45 and 37 for the bread of aforementioned wheat kinds respectively, when using white wheat as a standard material. It was noted that they were significant differences at the level ($p < 0.01$) among these values, which is a result less than what was found by Foster –Powell et al. (2002) and Thannoun and Al-Qubati (2005). The results also indicate that the Glycemic Index (GI) and Glycemic Load (GL) of the bread with 90% extraction are low compared to the Glycemic Index (GI) and Glycemic Load (GL) of white wheat bread, which is also slow as was also mentioned by Foster –Powell et al. (2002) and Foster –Powell and Brand –Powell (1995). The reason is due to the high ratio of raw fibers in bread, and this is what was shown in table (1) in terms of the noticeable difference between the ratio of fibers white flour and brown flour with an extraction 90% of the studied kinds for 6SHAM, 95Ipa, and 2Talafaar respectively, and this may be due to the processes that precede the preparation and baking of flour (Al-Qubati, 2003 and Thannoun (2005).

Table (6) shows the chemical composition of white bread, which is the product of wheat flour with an extraction 72% (Good flour), which is the wheat flour free from flour degree 2 and big bran and small bran prepared from wheat flour under study for the three kinds of wheat used to estimate the Glycemic Index in healthy volunteers on based it contains 50 g carbohydrates. As a result of determining the amount of carbohydrates, the meal provided to the volunteers of white bread, of 2Talafaar wheat flour, 6SHAM wheat flour, and 95Ipa wheat flour, weighing 93.67 g, contained 11.22, 1,21,0,84 and 0.92 g of protein, fat, raw fibers and ash respectively and from white bread of 6SHAM ,wheat flour weighing 94.5 contained 9,44, 1.45, 1.03 and 0.89 g of protein, fat, raw fibers and ash respectively, while the white bread of 95 Ipa wheat flour, weighing 93,25 g . It contained 7.96, 1.66, 0.90 and 0.91 g of protein, fat, raw fibers and ash respectively. These values are consentient with the values obtained by Al-Qubati (2003) for white bread as well, and are close to some of the values obtained by Aziz (2015) when it was relied on 50 g carbohydrates from the standard meal of white bread provided to volunteers. When comparing the composition of white flour bread with wheat kinds , it is noted that they are close in some values except for protein ratio of 2Talafaar flour bread , which was the higher compared to the protein ratio of 6SHAM and 95Ipa flour bread.

Table 6
Bread made from white flour with ratio extraction 72% of wheat kinds

Food type	Food weight before preparing (g)	Food ingredients (g)					Weight of eaten food (g)
		Carbohydrates	Protein	Fat	Fibers	Ash	
2talafar bread Extraction 72%	66.34	50	11.22	1.21	0.84	0.92	93.67
6sham bread extraction 72%	67.99	50	9.44	1.45	1.03	0.89	94 .5
95 Ieba bread extraction 72%	66.093	50	7.96	1.66	0.90	0.91	93.25

Table (7) shows the results of estimating the response of blood glucose , Glycemic Index (GI) and Glycemic load (GL) for the three kinds of bread produced from white flour with 72% extraction for the wheat kinds under study in the study coupled with the response to white bread and to glucose ad a standard material. The table indicates that the blood glucose response for white bread from the flour of the wheat cultivars under study gradually increased , where the blood glucose concentration increased gradually for bread made from white flour of the wheat kinds 6SHAM from 92 mg/dl at the beginning of measurement at time zero to 104 after 30 minutes from eating the meal and it rose until 60th minute to 123 as a maximum, after the concentration gradually decreased to 121 then 104 mg/dl after the time 90 and 120 minutes. While eating bread made from white flour for 95Ipa wheat, it showed an increase in blood glucose starting from the zero time in which the blood glucose response was 97 mg/dl to the maximum at the 60th minute, it reached 128 after the 30th minute in which it was 109 then the response ratio reached 113 and 101 mg/dl for the 90th and 120th minutes. While consuming 2Talafaar wheat flour bread, it was noted the blood glucose response was 112 mg/dl for the 30th minute after the base line in which it was 90 mg/dl reaching the highest limit at the 60th minute to reach 122 mg/dl, then the blood glucose response gradually decreased to 107 and 89 mg /dl after the 90th and 120th minutes and this is what figure (2) shows. It had a clear curve when the response was high compared to the standard glucose, where the blood glucose concentration increased from 97 mg/dl to the highest concentration of 109 and 128 mg/dl after 90 minutes of eating white bread and 30 minutes of eating standard glucose respectively table (7) after the 90th minute, blood glucose decreased directly to the concentration of base line at 120th minute.

Table 7
Blood glucose response and Glycemic index and Glycemic load of the white bread
for the healthy persons

Food type	Blood glucose response					IAUC Mg/dl/m in	Gig	GLg	Gib	GLb
	mg/dL/min									
	Time / minute									
	0	30	60	90	120					
White bread 95Ieba	97	109	128	113	101	2900 Ba	76dbc	38 fg	100	50feg
White bread 2talafr	90	112	122	107	89	2362 B	62 fc	31g	81bac	41 fg
White bread 6sham	92	104	123	121	104	2762 Ba	7 bc	36 fg	95ba	48 feg
Glucose	95	119	142	123	94	3805 A	100 A	50 fg		

The numbers represent 3-4 replicates. Vertically different letters indicate that there are significant differences at the level ($p < 0.01$) GIg and GLg Glycemic Index and Glycemic Load respectively when using Glucose a standard food. Gib and GLb Glycemic Index and Glycemic Load respectively when using white bread a standard food. (IAUC): Area under curve mlg/disleter.

Table (7) shows the area under the curve (IAUC) for Glycemic Index and Glycemic Load (GL) for white wheat bread for wheat flour 6SHAM, 95Ipa and 2Talafaar among healthy volunteers. The area under the curve for blood glucose response when eating white wheat bread for 6SHAM wheat, 95Ipa, and 2Talafaar was 2762, 2900 and 2362 mg/dl/min respectively compare to 3805 mg/dl/min for the standard glucose and the table shows that there are significant differences at the level ($p < 0.01$) among these values. The table indicates that the Glycemic Index (GI) for each of white bread of 6SHAM wheat, 95Ipa wheat, and 2Talafaar wheat reached 73, 76 and 62 respectively, and the Glycemic Load (GL) amounted to 36, 38 and 31 for 6SHAM wheat bread, 95Ipa wheat bread, and 2Talafaar wheat bread respectively coupled with the use of glucose as a standard material .

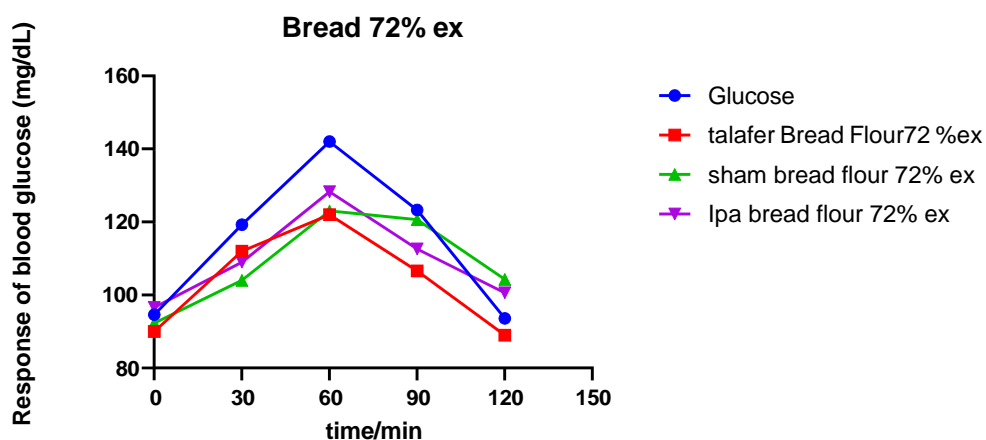


Figure 3. Response of blood glucose, glucose index and glucose load to white bread in healthy persons

Table (8) shows the values of the glycemic index and the glycemic load of the bread produced from the wheat cultivars under study with the above-mentioned extracts in healthy persons, as it is noted that the glycemic index and the glycemic load of the bread made from 2Talafar wheat flour with a complete extraction rate were superior to this trait by a significant difference ($p < 0.01$) on the values of glycemic index and glycemic load of bread produced from flour of wheat varieties sham 6 and Iba 95 with complete extraction, and the reason for this may be due to the high content of wheat flour Talafar 2 of protein. Carson and Edwards, 2009), which is reflected in the value of the glycemic index (Lal et al. (2021).

Table 8

The values of glucose index and glucose load of bread of wheat varieties under study with its three extracts in healthy persons

Extraction % wheat variety	%011		%01		%27	
	GI	GL	GI	GL	GI	GL
Sham6	46 e-j	23 J	54 c-g	27 Ij	73 B	36 f-j
Talafar2	37 f-j	19 J	56 b-f	28 Ij	62 b-e	31 hij
09Ipa	47 e-i	23 J	68 bcd	34 g-j	76 B	38 f-j
standard glucose	100 A	50 d-g	100 a	50 d-g	100 a	50 d-g

The numbers represent 3-4 replicates. Vertically different letters indicate that there are significant differences at the level ($p < 0.01$).

Conclusions

Through the results that were reached, it was found that the ratio extraction of flour affects the Glycemic Index (GI) of foods, eating bread prepared from the whole wheat flour, whether 90 or 100% extraction, therefore it is recommended to use it in the nutrition program for people with diabetes type 2.

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