

Effect Of Addition Of L-Ascorbic Acid To Wheat Bread Dough On Blood Glucose Response, Glycemic Index And Glycemic Load In Normal Subject

Abdullah M. Thannoun , Roqaya Fouad Lafy Al-Arajy

Food Science Department, Collage of Agriculture and Forestry, University of Mosul

Roqayafouad@uomosul.edu.iq

DOI: 10.47750/pnr.2022.13.S08.73

Abstract

The aim of this study was to determine the effect of ascorbic acid (Vitamin C) as improver in bread on blood glucose response (BGR), Glycemic Index (GI) and Glycemic Load (GL) in healthy subjects. Three concentration of ascorbic acid namely, 5ppm, 10ppm and 15 ppm concentration were added to Ab-Graib wheat flour of 72 and 90% extraction in making local flat bread. Chemical composition of flour and produced bread and sensory properties were determined in order to assess the quantity of bread intake by Volunteers (Undergraduate and Graduate students in collage of Agriculture and forestry, University of Mosul) with BMI between 20-24 Kg/m². Results show that bread samples which fortified by ascorbic acid had good and acceptable sensory properties. Both GI and GL were reduced in both 72 and 90% wheat flour extraction rate. The effect of addition of ascorbic acid in decreasing GI and GL was more in bread made from 90% flour extraction than bread made from 72% flour extraction, and this may be because of the more dietary fibers that 90% flour extraction contained. It was concluded that addition of ascorbic acid in précised quantity resulted in decreasing GI of bread made of 72 and 90% flour extractions with minimal increasing in higher concentrations.

Key words: L-Ascorbic acid, Wheat Bread, Blood, Glucose, Glycemic.

Introduction

Jenkins et al. 1981 introduced the concept of the glycemic index (GI) for diabetic patients to determine the glycemic response of different carbohydrate foods. The high-GI food gives a larger area under the glucose curve over the postprandial period when compared to the equivalent carbohydrates found in the low-GI diet (Jenkins et al., 1981). The glycemic index of a particular food is a useful function for understanding the relative classification of different foods, but it does not accurately reflect the effect of a real portion or meal of the food on blood sugar. From here came the concept of glycemic load (GL), which includes both the quality and quantity of carbohydrates in a single value. Glucose load is a more accurate way of predicting and expressing the effect and amounts of different nutrients (Salmeron et al., 1997; UW, 2018). The glycemic index values are affected by a number of factors, including the variety and ripeness of food, the method of processing, cooking processes, and food storage, in addition to food components and the presence of nutrients other than carbohydrates such as fats, proteins, organic acids, dietary fiber, resistant starch, as well as substances Antinutrients and improved food additives (Lal et al., 2021 and Trumbo, 2021 and Haini et al., 2022).

The consumption of bread as the main food item by most societies leads to a sharp rise in the response of blood glucose and insulin in the body, and as a result leads to the occurrence of diabetes and its complications, and due to the high percentage of carbohydrates and their load in baked goods in general, they belong to foods with a medium to high glucose index (Henry et al., 2021 and ADA, 2022). In this case, lowering the index is of particular importance, and thus can positively affect the hypoglycemic response (Borczak et al., 2018 Zhu and Li, 2022). In order to change that, it is possible to use vegetable raw materials rich in dietary fibers and antioxidants, modify the traditional milling processes or prepare bread by following some of the processes that take place before and after the post-baking processes, such as reducing the kneading period, increasing fermentation, using acidic fermentation, and reducing the amount of yeast (Borczak et al. 2018).

L-Ascorbic acid, LAA (vitamin C) is a vital nutrient in the body, it is an anoxic reducing agent that is easily oxidized and used as an improved in dough and bread making (Khan et al., 2022). Its importance in biochemical processes comes as a strong reducing agent and stabilizer, and on the basis of these properties, it can be used in the bakery industry (Varvara et al., 2015). In addition to being a reducing agent, it is oxidized in the wheat flour paste to L-Dehydroascorbic acid by the enzyme ascorbate oxidase present in the wheat and thus plays a double role as an oxidizing and reducing agent (Dai and Tyl, 2021). The resulting bread when adding ascorbic acid is characterized by its high quality due to the strengthening of the dough protein network by creating sulfur bonds between the peptides that make up the flour protein, as a result of converting sulfhydryl groups into sulfur bonds, which leads to the strengthening of the dough and increases its ability to retain gas and increase the volume of bread (Topcu and Karatas, 2017; Jia et al., 2022). Therefore, the aim of this research was to study the effect of adding ascorbic acid as an enhancer to local flatbread on blood glucose response and glucose index in normal humans.

Materials and Method

Wheat and used samples:

The grain of wheat, Abo Graib, was obtained from the Mesopotamian Company, and it is an approved and certified variety. The impurities, bushes, and dust stuck to the wheat were cleaned and removed by passing the grains through a sieve with holes diameter of 20 x 2.2 mm, and the samples were cleaned with a Tripette & Renaud N.S.P. French made, which operates with a vacuum suction system. Then the samples were placed in polyethylene bags and kept in cold rooms at -1520° C until used in the next step.

Laboratory Milling:

The moisture percentage in the grains was measured as stated in the standard method (44-19) AACC (2000), then the amount of water needed to be added to bring the moisture to 15% was calculated depending on the initial moisture to obtain flour with a moisture content of 14%, after calculating the required amount of water, water was added to the grains and leave for 24 hours in nylon bags (Tempering) with stirring several times to homogeneous distribution of moisture except for 1% of the water was added half an hour before the grinding process.

Wheat Milling:

Grains were milled using a German-made BUHLER MLU 202 mill located in the laboratories of the General Company for Grain Processing. Then the samples were kept in polyethylene bags in the refrigerator until tests were conducted on them. Where we obtained flour with an extraction rate of 72%. As for flour with an extraction rate of 90 and 100%, 90% was obtained by re-milling the bran and then extracting it again and leaving the rest that was Considered 100% extraction.

Chemical and rheological tests were carried out in the laboratories of Mosul University / College of Agriculture and Forestry / Department of Food Sciences and the General Company for Grain Processing, Nineveh Branch, and Baghdad Branch.

Chemical determinations of wheat and flour:

Moisture Determination: The percentage of moisture was estimated in a typical oven type 10026-59 Italian-made Proodit according to the standard method (44-19) AACC (2000).

Fat Determination: : The percentage of fat in samples was estimated using Soxhlet extraction units and using the solvent petroleum ether with a boiling point of 60 80 °C up to ten times of siphoning, as followed in AOAC (2000).

Protein Determination: The protein was estimated by the Micro-Keldal method (11-46) AACC (2000) by estimating the nitrogen in the sample and multiplying the result by the factor (5.7) of the grains.

Ash Determination: The ash was determined in the samples according to the method mentioned in AOAC 2000) using a Muffle Furnace at a temperature of 550 °C for 3 hours until a grayish-white substance was obtained.

Crude Fiber: The method mentioned in AOAC 2000) was used to estimate the crude fiber using acid-base digestion.

Carbohydrate determination: Carbohydrates were estimated for the sample by calculating the difference from :100, according to Nwosu et al. (2014) and as follows
% Carbohydrates = 100 - (% Moisture + % Protein + % Fat + % Ash + % Fiber).

Manufacture of bread: by following the method mentioned by AL-Mamoori (2015), as the bread was prepared according to the Iraqi Standard Specifications No. 677 of 1983. The components of the bread were as follows: 100 gm of flour, 1 gm of yeast, 1 gm of salt, 0.5 gm of sugar, and the amount of water according to the scheme Farinograph for each sample at 30°C. The ingredients were mixed manually until a homogeneous dough was obtained and the sample was left to ferment for 30 minutes at room temperature (25 ± 2°C), and baked in an electric oven at a temperature of 230 ± 10°C for 3-5 minutes, after which the bread was left to cool at room temperature. In polyethylene bags and kept frozen until use.

Formulated Bread: In order to find out the effect of ascorbic acid on the characteristics of the dough, the resulting bread, the glucose index, and the glucose load, the quantities shown in Table (1) were added to the mixture of each of the dough flour extracted 72 and 90%, as in the previous paragraph of bread making and as follows:

Table (1): Concentrations used of ascorbic acid as an additive

Addition amount ppm				additive
15	10	5	0	L-ascorbic acid

Nutritional and Biological Experiment

Volunteers: 27 volunteers participated in the biological experiment, their ages ranged between 20-29 years, most of them were undergraduate and graduate students at the College of Agriculture and Forestry/Mosul University, and their body mass index (BMI) ranged between 20-24 kg/m², all volunteers are in good health Healthy They were divided into groups in order to facilitate the task of conducting the experiment over the period of conducting the research, as all three of them were subjected to take the required measurements.

Blood Glucose Response: The blood glucose response is the translation of a measure of levels of blood glucose concentrations over time, usually at 0, 30, 60, 90, and 120 minutes, into information and a graph and then an estimate of the Incremental Area Under 2h blood glucose curve (IAUC) and comparison with the reference, which is Usually pure Glucose or White Bread (Jenkins et al., 1981 and FAO/WHO (1998).

Determination of Glycemic Index (GI): The glycemic index of the food prepared in the experiment was measured according to the method he invented

Jenkins et al. (1981) and published the participants of the Food and Agriculture Organization of FAO and WHO (FAO/WHO, 1998) with the participation of volunteers, as all three of them were subjected to a GI measurement of samples and a standard food (glucose), as each sample contained 50-gram carbohydrates. After fasting for 10-12 hours, blood samples were taken from the pricked capillary finger at the beginning of the experiment before eating food, and after eating food by the volunteers, blood samples were taken from the volunteers' fingers at intervals of 0, 30, 60, 90 and 120 minutes. The glucose percentage in the blood samples taken from the volunteers participating in the experiment was measured directly using one-touch test strips. The GI of each food was calculated by calculating the increase in the area under the response curve for blood glucose (IAUC) for two hours for each tested food and the area Under the blood glucose response curve for the same period for the standard food which is glucose and white bread.

The GI was calculated according to the following equation:

$$GI = \frac{\text{IAUC for diet}}{\text{IAUC for glucose or white bread}} \times 100$$

The area under the blood glucose response curve was calculated without ignoring the area under the baseline according to the method mentioned in the FAO/WHO (1998) and the area under the curve was calculated using an electronic calculator.

Glycemic Load (GL): The glucose load was calculated according to the following equation:

$$GL = GI \times \% \text{ net Carbohydrate} \\ \text{Net Carbs} = \text{Total Carbs} - \text{Dietary fiber}$$

Sensory Evaluation: The bread was sensory evaluated according to the method mentioned in (AACC 2000) and according to a special form presented to a number of assessors, most of whom were students and professors of the Department of Food Sciences.

Statistical analysis: The results were analyzed using the Social Program Statistics System (SPSS) according to the ANOVA test, and the arithmetic means were compared using Duncan's polynomial test with a level of significance ($P \leq 0.05$ (Duncan), 1955).

Results and Discussion:

Table (2) shows the chemical composition of whole wheat flour and flour extracted with extraction percentages of 72, 90, and 100% and their comparison with Turkish Cihan flour. The results show that the moisture content ranged between 12.39% in the studied whole grain wheat and 13.47% in the commercial whole grain flour (100% extraction). The table below shows that the moisture content was 13.07 and 13.45% in each of the extracted flour at 72 and 90%, respectively, which is relatively high compared to the types of commercial whole flour (12.39%) and Jahan commercial flour of Turkish origin (12.54%), and the reason may be due to the preparation process Flour and moisten the wheat before grinding. It is noticeable that there are significant differences ($P \leq 0.05$) between these samples. As for the percentage of fat in the samples, it ranged between 0.27% in 72% extraction flour and 2.20 and 2.43% in whole wheat grains under study and commercial whole flour (100% extraction), respectively, and when the flour was extracted at 72 and 90%, the percentage decreased to 0.27 and 0.56%, respectively, compared to relatively low percentages (1.46%) for Jahan commercial flour. The results indicate that there are significant differences ($P \leq 0.05$) between the studied samples and the commercial flour samples.

Table (2) shows that the protein percentage ranged between 10.07% in 72% extraction flour, which is low and the highest, which is 12.48% in 90% extracted flour, while it was 11.26 and 11.45% in both whole wheat grains and commercial wholemeal flour (100% extraction). , Straight. It is noticeable that there are significant differences ($P \leq$

0.05) between these samples. The table also indicates that the percentage of ash was slightly higher for samples of whole grains and commercial total flour (100% extraction) (1.99 and 1.65%, respectively) and decreased significantly ($P \leq 0.05$) to 0.46, 1.24, and 0.3% for each extraction flour. 72 and 90% and Jahan commercial flour, respectively. It decreased gradually and significantly ($P \leq 0.05$), perhaps with the extraction and exclusion of the bran, which is a source of ash and mineral elements. Therefore, flour with a higher protein and gluten content, and a whiter one, is obtained with a lower degree of extraction (Ahmed et al., 2020).

Table (2) Chemical composition of cereals and flour under test

sample type	% chemical composition					
	Humidity	fat	Protein	ash	fiber	carbohydrates
whole grains	12.39 b	2.20 a	11.26 b	1.99 a	3.70 b	69.72 b
flour extraction 72%	13.07 ab	0.27 b	10.07 c	0.46 d	0.96 c	75.08 a
extraction flour 90%	13.45 a	0.56 b	12.48 a	1.24 c	2.70 b	68.23 b
whole meal flour 100%	13.47 a	2.43 a	11.45 b	1.65 b	5.34 a	66.51 b
Cihan Flour	12.54 ab	1.46 ab	10.90 bc	0.30 d	0.45 c	74.37 a

The numbers represent the average of three replicates. * Carbohydrates are calculated based on the difference between ingredients.

The different letters in the same column indicate the presence of significant differences at the level ($P \leq 0.05$).

Table (2) also shows that the percentage of fibers changed significantly ($P \leq 0.05$) with the extraction process. It is noticeable that the percentage of fiber in whole wheat grains was 3.70% and decreased significantly ($P \leq 0.05$) to 0.96% and 2.70% when they were extracted at 72 and 90%, respectively. While the percentage of fiber was low (0.45%) for commercial flour of type Jahan and high (5.34%) and significant ($P \leq 0.05$) for total commercial flour. The reason for this decline after extraction operations may be due to the exclusion of the bran and husks of wheat, in which dietary fiber is concentrated, which is its natural presence.

Based on the values of the above-mentioned components, the percentage of carbohydrates changed, as they are the sum of the remaining components, and it was calculated on the basis of the difference between the sum of the other components and the weight of the total sample calculated on the basis of 100%. For this reason, the percentage of carbohydrates was relatively high (75.08, 68.23 and 74.37%) in each of 72 and 90% extracted flour and Jahan commercial flour, respectively, compared to 69.72 and 66.51% in whole grain and commercial whole flour, respectively. It is showed from the results of the table that there is a difference in the percentage of moisture. The reason may be due to the relative increase in moisture for the initial hydration process before grinding, or the balance between the ability of the different components to bind with water, especially fibers, and carbohydrates. And there was a significant decrease ($P \leq 0.05$) in the percentage of fat, protein, ash, and fiber between types of whole wheat flour and extract flour at percentages of 72, 90, and 100% and Jahan flour. The reason is that the components of these types of flour, some of which are more concentrated in the outer shell and whole seed husks, especially if their extraction is 100%, and some of them increase their presence in the seed (Bressiani et al., 2017). Therefore, with the increase in the degree of extraction, the flour content of protein, fiber, sugars, fats, and mineral elements increases, except for starch, which decreases (Vetrimani et al., 2005). In general, flour with a higher ash content is obtained by increasing the degree of extraction up to 85%, while flour that is higher in gluten and whiter can be obtained with a lower degree of extraction (Ahmed et al., 2020).

We note that the values in Table (1) are compatible with or close to the results obtained by Mepba et al. (2007), Kulkarni et al. (2012), Ngozi (2014), Bressiani et al. (2017) and Ocheme et al. (2018). The difference in chemical composition may affect the properties of the flour dough, the degree of water absorption, the formation of the gluten network, and the properties of the dough including hardness, viscosity, elasticity, extensibility, water retention, cooking properties such as shape recovery, chewing viscosity, product strength, and shrinkage, etc., which are important in the properties of bread and pastries (Huang and Lai, 2010 and Marchetti et al., 2012).

Organoleptic properties of bread :

Bread made from 72% extracted flour:

Table (3) shows the sensory characteristics of bread samples made from flour extracted with a percentage of 72%. It is noted that the sample added to ppm5 and ppm10 ascorbic acid outperformed the rest of the samples under study, including the control sample (extraction flour 72%) in bread color. The degree of evaluation of these samples reached 9.17 degrees for each of them compared to the bread of the control sample (7.83 degrees), and these values did not differ significantly ($P \leq 0.05$) from what was obtained by the rest of the bread samples. With regard to the characteristic of the color of the back of the bread, it was significantly ($P \leq 0.05$) that the Jahan flour bread sample and the bread added to it ppm10 ascorbic acid were significantly superior ($P \leq 0.05$) compared to the color of the back of the bread of the control sample that got the least Evaluation score (6.83 points). In terms of color homogeneity, all bread samples did not differ in the degree of homogeneity significantly ($P \leq 0.05$) among themselves, but they were superior to the control sample, which obtained the lowest degree among the samples (7.33 degrees). The quality of bread can be measured by the golden brown crust along with the creamy white pulp. The color of the crust is a vital indicator of the quality of the bread, so color is a critical factor in the quality of bread because it influences the decision and interests of consumers (Hoque et al., 2022).

Table (3): Sensory characteristics of flour samples extracted 72% using food additives.

The type of flour from which the bread is made	studied traits							
	face color	back color	color homogeneity	Inflatable, hand Cutability and chewable	smell	Taste	regularity of shape	total
	Degree							
	10	10	10	15	10	15	10	80
Control sample (72% extraction flour)	7.83bc	6.83c	7.33c	12.67a	8.30ab	12.67bc	7.67c	63.3b
Cihan Flour	8.83ab	9.17a	8.66abc	13.67a	8.67ab	13.00ab	8.67ab	70.67a
Whole wheat flour	8.33abc	8.33ab	8.83ab	10.83b	8.80ab	11.5d	9.17a	65.29b
ascorbic acid 5 ppm	9.17ab	8.83ab	9.00ab	13.33a	9.00a	12.83bc	8.83ab	70.99a
ascorbic acid 10 ppm	9.17ab	9.33a	8.33bc	13.67a	9.50a	14.17a	9.17a	73.34a
ascorbic acid 15 ppm	9.00ab	8.83ab	8.16bc	13.00a	8.60ab	12.00cd	9.17a	68.76ab

The numbers represent the averages of 12 replicates

The different letters in the same column indicate the presence of significant differences at the level ($P \leq 0.05$).

As for the rubbery character and the ability to cut by hand and chewing, most of the samples obtained a high value, and the significant differences ($P \leq 0.05$) were few between the samples. While the value of the whole flour sample was less, as it was 10.83, and the reason for this may be due to the high percentage of bran in the whole flour compared to the other samples under study, which affects this characteristic and this corresponds to the high ability to bind water by the bran and the inability to retain this moisture, which It negatively affected this trait for commercial wholemeal flour and this is consistent with the finding of Hrivna et al. (2018). Saka et al. (2021) mentioned that oat bran negatively affected the rheological properties of the dough and in turn the quality of bread, especially if its percentage exceeded 10% of the flour used.

Taste and smell are one of the most important factors for sensory evaluation, as taste and smell refer to the comfortable feeling that the product causes in the mouth due to its analytical effect (Bhat et al., 2015). Table (2) shows that there are no significant differences between the samples in terms of smell, but the matter differed slightly in terms of taste, as it is noticeable that there are significant differences ($P \leq 0.05$) between bread samples in the quality of taste. It is also noticeable

The sample added to 10ppm ascorbic acid significantly outperformed the study samples by obtaining the highest significant value ($P \leq 0.05$), as it was 14.17 degrees, while the whole flour sample obtained the least significant value ($P \leq 0.05$) for this trait, as it was 11.5, and this may It goes back to the dietary habits of the residents and their dependence on white bread in their diet. As for the regularity of the shape, the differences were significant ($P \leq 0.05$) between the samples, except for the control sample, which obtained the least significant value ($P \leq 0.05$), which is 7.67 degrees compared to the degrees obtained by the samples added to ascorbic acid in every proportion.

The last column of Table (3) shows the general acceptance values with significant differences ($P \leq 0.05$) between the samples. The table shows that the bread samples supplemented with ppm5 and ppm10 ascorbic acid obtained the highest scores of 70.99 and 73.34 degrees, respectively, but they decreased slightly in the eye supplemented with 51 ppm ascorbic acid, which got 68.76 degrees. While the sample of fully extracted flour obtained the lowest value as it was 65.29 degrees, the high proportion of bran in this type of flour, which consequently leads to the hardness of the loaf, led to a decrease in the sensory values of the samples. This is consistent with what Mello et al. (2014) indicated that adding bran or fiber generally weakens the structure of bread due to the interaction of fibers with gluten, which leads to a decrease in the gas retention capacity and a decrease in the volume and elasticity of the pulp, and consequently consumers do not accept bread as it is dark brown in color and has a hard shell. For this reason, the Overall Acceptability (OAA) of a food sample expresses how consumers or members of the evaluation committee accept the product by considering all of the sensory rating factors mentioned (Bhat et al., 2015).

Organoleptic properties of bread:

Bread made from 90% extracted flour: From table (4) for samples of bread made from flour extracting 90%, it is clear that the sample of bread made from Jahan flour obtained significant ($P \leq 0.05$) in the color of the face and the back, reaching 8.83 and 9.17 degrees, respectively, compared to the control sample that obtained at 7.60 and 7.66 degrees, respectively, too. While the evaluation scores of the bread samples made from flour added to ascorbic acid slightly decreased to 7.5 and 7.33 for the face and back color, respectively, and 7.8 and 7.33 for the face and back color, respectively, also for the sample added with ppm10 ascorbic acid and ppm15 ascorbic acid on the straight too. As for the color homogeneity, the control bread sample (extracted flour 90%) was significantly ($P \leq 0.05$) low, as it was 7.33 compared to the bread samples supplemented with 5ppm ascorbic acid, which obtained the highest value significantly, as it was 10, and this value slightly decreased. High levels of ascorbic acid addition. Table (4) indicates the results of elasticity and the ability to cut by hand and chewing, as there are no significant differences between the samples, although the sample of bread manufactured from Jahan flour and the sample added to ppm10 ascorbic acid obtained 13.67 and 13.0 degrees, respectively, while this characteristic decreased in the sample manufactured from Total flour to 10.83 degrees. The effect of whole wheat bran is responsible for the color of the bread crust and for the

rheological properties, including the properties of bread and its elasticity, and this is due to the dietary fiber and high phenolic substances present in the bran, which give the dark color to whole wheat flour (Hoque et al., 2022). As for the taste and smell, it is noticeable that there are no significant differences ($P \leq 0.05$) between the samples, even though the bread sample to which ppm15 ascorbic acid was added got 9.0 degrees with the smell of bread. The saying also applies to the characteristic of the regularity of the shape, as there are no fixed standards to some extent because the formulation, manufacturing processes, and dates of manufacture of commercial bread were different, which may lead to differences in the quality of bread (Mello et al., 2014). In the end, all samples obtained close degrees in the final evaluation, ranging between 63.93 degrees for the sample of bread made from control flour (extract 90%) and 70.67 degrees for the sample of bread made from commercial Jahan flour, with significant differences ($P \leq 0.05$) between the samples. Tarar et al. (2010) noted that among the sensory characteristics of the different samples, which are affected by these additives, are the difference in bread size, crust color, symmetry of shape, shortening properties, graininess, and pulp color.

Simić et al. (2021) reported that the addition of 0.025% ascorbic acid had no effect on the springiness, cohesiveness, and resilience of wheat-corn-bread crust. While the hardness of the crust is increased by crumb hardness. However, adding 0.025% ascorbic acid and 5% sugar had a negative effect on the specific volume of bread. However, the compound bread made after adding ascorbic acid and sugar together gave a more cohesive structure with more cells and an average of smaller areas. Compound bread to which ascorbic acid and sugar have been added together is characterized by a lack of elasticity, a sign of brittleness, which reflects the state and shape of the bread that crumbles when cut. However, the sum of the results of their sensory evaluation proved that the addition of ascorbic acid and sugar together had a positive effect on the sensory characteristics studied in general.

In another experiment on the use of natural sources of ascorbic acid, the powder of one of the tropical fruits, Acerola, which contains a high percentage of ascorbic acid (vitamin C) was used as a dough improver in the manufacture of white and whole bread. It was found that this powder had an effect similar to ascorbic acid, as it increased the strength of the bread cells and the cohesion of the dough without reducing its elasticity, as well as the time of development of the dough rise and softness, as well as it increased the specific volume of white bread and reduced the hardness of white bread and whole bread without leading to changes in the color of the crust and pulp (Franco et al., 2022).

Table (4) Sensory characteristics of samples of flour extracted 90% using food additives

The type of flour from which the bread is made	studied traits							
	face color	back color	color homogeneity	Inflatable, hand Cutability and chewable	smell	Taste	regularity of shape	general admission
	degree							
	10	10	10	15	10	15	10	80
Control sample (72% extraction flour)	7.60 bc	7.66 bc	7.33 c	12.67 a	8.33 ab	12.67 abc	7.67 c	63.93 b
Cihan Flour	8.83 a	9.17 a	8.67 abc	13.67 a	8.67 ab	13.00 ab	8.67 abc	70.67 a
Whole wheat flour	8.33 ab	8.33 ab	8.83 ab	10.83 b	8.83 ab	11.50 cd	9.17 ab	65.82 b

ascorbic acid 5 ppm	8.10 ab	7.67 bc	10 a	12.33 ab	8.83 ab	12.83 ab	8.67 ab	68.43 ab
ascorbic acid 10 ppm	7.50 bc	7.33 c	8.50 bc	13.00 a	8.17 ab	12.50 bc	9.17 ab	66.17 b
ascorbic acid 15 ppm	7.80 bc	7.33 c	8.17 bc	12.50 a	9.00 a	12.67 abc	8.17 bc	65.64 b

The numbers represent the averages of 12 replicates

The different letters in the same column indicate the presence of significant differences at the level ($P \leq 0.05$).

The efficiency of organoleptic tests lies in the fact that changes that occur in the product during storage are detected through organoleptic tests, in terms of taste, smell, color, appearance, and general acceptability, which are the most obvious criteria, and these changes can lead to product deterioration and the consequent decrease in acceptability Among consumers (Elfa, 2011 & Hussain et al., 2022). Also, organoleptic testing is a powerful tool for establishing the shelf life of most perishable and semi-perishable foods, and organoleptic properties of bread are critical indicators because consumer preference depends on the organoleptic quality (Hoque et al., 2022).

Ascorbic acid

Blood glucose response and glycemic indexes BGR, GI and GL

Bread Flour Extraction 72%:

Table (5) and Figure (1) show the response of blood glucose, glucose index, and glucose load for types of bread made from wheat flour extraction of 72% and bread made after adding ascorbic acid and comparing that with total flour bread and Jahan flour commercial bread. The table indicates that the blood glucose response was 94, 85, 88, 94, and 92 mg/100 ml at the beginning of the examination in the morning after hours of fasting for each of the control samples (72% extraction flour) and bread added to it 5, 10 and 15ppm ascorbic acid and total bread (100% extraction), respectively, To become 114, 101, 109, 109, and 106 mg/100 ml after 60 minutes of eating bread, respectively, then the concentrations of glucose in the blood gradually decreased to reach the lowest concentration of 97, 92, 91, 88, 97 mg/100 ml, and perhaps the normal fasting level for both the control sample and the added bread. It is 5, 10, and 15ppm ascorbic acid and total bread, respectively, after 120 minutes of measurement. It is noticeable from Figure (1) that the total bread curve (100% extraction) has a tendency to be slightly flatter than the rest of the other curves, especially the glucose curve. Curvature as a result of high blood glucose concentrations, where the blood concentration increased from 88 to 122 mg/100 ml in the first half hour of measurement. Table (5) shows that the surface area under the curve amounted to 1275, 1215, 1185, 1230, and 1065 mg/100ml/min for each of the control samples and the bread added to it 5, 10, and 15ppm ascorbic acid and the total bread, respectively, compared to 1275 and 1815 mg/100ml/min for each of the white bread and standard glucose, respectively. It was noted that there were no significant differences ($P \leq 0.05$) between the values of the area under the curve for glucose response to the bread samples of the control sample and the effect of adding ascorbic acid used.

Table (5) Blood glucose response, glucose index, and glucose load for processed bread from flour an extraction rate of 72% by adding ascorbic acid.

	Blood glucose response, mg/100ml		glucose	white bread
	time/minute			

The type of flour and bread it is made from	0	30	60	90	120	Area under the curve mg/ml/min	GIg	GLg	GIb	GLb
0 ascorbic acid (extract 72%)	94	106	114	103	97	1275 b	70 b	35 a	100 a	50 a
ascorbic acid 5 ppm	85	98	101	93	92	1215 b	67 b	34 a	97 a	48 a
ascorbic acid 10 ppm	88	99	107	96	91	1185 b	65 c	33 ab	93 ab	46 ab
ascorbic acid 15 ppm	94	110	109	106	88	1200 b	66 b	33 a	94 a	47 a
whole meal flour 100%	92	103	106	100	97	1065 c	59 c	29 b	83 b	42 b
white bread	91	101	109	102	98	1275 b	70 bc	35 a		
standard glucose	88	122	113	94	79	1815 a	100 a			

The numbers represent the average of three replicates

Different letters in the same column mean that there is a significant difference ($P \leq 0.05$).

GI g and GLg glucose index and glycemic load, respectively, when standard food glucose is used.

GIb and GLb glycemic index and glycemic load, respectively, when white bread is used as standard food.

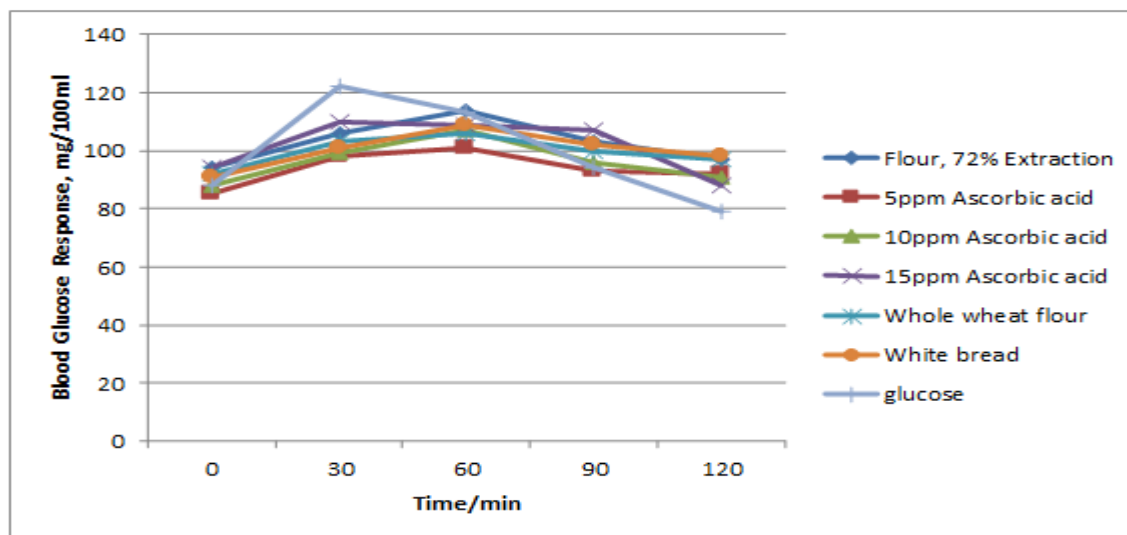


Figure 1: Blood glucose response to wheat bread made from flour with an extraction rate of 72% by adding ascorbic acid.

As a result of the results of the blood glucose response, the glucose index reached 70, 67, 65, 66, and 59 for each of the control samples (bread flour extraction 72%), and the bread with added 5, 10, and 15 ppm ascorbic acid and total bread, respectively, while the glucose load reached 35, 34, 33, 33 and 29. Also, when using glucose as a standard diet, with significant differences ($P \leq 0.05$) between samples. When using white bread as a standard food, the glucose index

reached 100, 97, 93, 94, 83, and the glucose load reached 50, 48, 46, 47, and 42 for each of the control samples and bread added to it 5, 10 and 15ppm ascorbic acid and total bread, respectively, with significant differences ($P \leq 0.05$) between the samples. (Table 5 and Figure 1). It is noticeable that the glucose index and glucose load decreased slightly (67 and 34, respectively) when adding 5ppm ascorbic acid and decreased significantly ($0.01 > P$) to 65 and 33, respectively when adding and 10ppm ascorbic acid, but these indices increased slightly (66 and 34), respectively) the bread sample was supplemented with 15ppm ascorbic acid, all when glucose was used as a standard diet. The saying holds true when white bread was used as a standard food. The same can be said when we used 72% extraction flour, the addition of ascorbic acid in regulated and limited quantities (5ppm and 10ppm ascorbic acid) led to a decrease in the glucose index. It is possible that this non-positive effect occurs by indirectly increasing the concentration of the glucose index by affecting the characteristics of the dough and the resulting bread, especially the dough's hardness and flexibility through the formation of gluten nets. These results are consistent with what was found by Mason et al. (2019), who observed, after taking ascorbic acid as a dietary supplement, a significant decrease in the daily postprandial glucose IAUC. Through the same researchers as well and through short-term studies, it was found that there are indications that the use of vitamin C in fortification of foods led to better control of blood glucose and blood pressure in people with type 2 diabetes, but it was not Taking such results through this study completely, as it needs confirmation through a broader study with a longer term (Mason et al., 2021). Koehler (2003) found that units of cysteine bound with small peptides of glutenin protein are present in the form of the thiol (SH-) group in flour. During the kneading process, it turns into sulfur bonds between proteins, as well as through the bonds formed by the glutathione peptide in the oxidized formula as part of the sulfur bonds it contains, and this is formed by the action of ascorbic acid to give opportunities to form active groups in the form of active groups of thiols and opportunities to form sulfur bonds or bonds between dough proteins To form a gluten network in which the purity of the bread can be improved. And on the assumption that by changing and increasing the bonds of flour and bread proteins and producing a cohesive dough, leads to disruption of starch decomposition in bread and as a result leads to a decrease in glucose indicators (Simić et al., 2021).

Blood glucose response and glycemic indexes BGR, GI and GL

Bread Flour 90% Extraction:

Table (6) and Figure (2) show the response of blood glucose, glucose index, and glucose load for types of bread made from wheat flour (90% extraction) and bread made after adding ascorbic acid and compared to total flour bread and Jahan flour commercial bread. The table indicates that the blood glucose response was 85, 81, 85, 93, and 92 mg/100 ml at the beginning of the examination, which is the concentration of the fasting level for each of the control samples (extracted flour 90%) and bread added to it 5, 10 and 15ppm ascorbic acid and total bread (100% extraction), respectively, To become 98, 95, 105, 109, and 106 mg/100ml after 60 minutes of eating bread, respectively, then the concentrations of glucose in the blood gradually decreased to reach the lowest concentration of the fasting level, which is 92, 86, 82, 98, and 97 mg/100ml for each of the control sample and the added bread. 5, 10, and 15ppm ascorbic acid and total baking, respectively, after 120 minutes of measurement. Note the response of blood glucose through the curve in Figure (2). The curves of both ascorbic acid supplemented bread and total bread (100% extraction) tended to flatten slightly, with a decrease in blood glucose concentrations between the beginning and end of the examination compared to the rest of the other curves, especially the curve Standard glucose tends to convex as a result of high blood glucose concentrations between the beginning and end of the examination, where the blood concentration increased from 88 to 122 mg / 100 ml in the first half hour of the measurement. As a result of these readings with blood glucose response levels, the surface area under the curve was 1220, 1065, 1035, 1095, and 1065 mg/100ml/min for each of the control samples and bread supplemented with 5, 10, and 15ppm ascorbic acid and total bread, respectively, compared to 1275 and 1815 mg/100ml/min for each of White bread and standard glucose, respectively. It is noticeable that there are significant differences ($P \leq 0.05$) between the values of the area under the curve for glucose response in the control bread sample and the effect of adding ascorbic acid used and the total bread sample when glucose is used as standard food. While there was no significant difference ($P \leq 0.05$) between the values of the

area under the curve for blood glucose response for samples supplemented with ascorbic acid, although it decreased to 1065, 1035, and 1095 mg/100 ml/min for bread samples supplemented with 5, 10 and 15ppm ascorbic acid, respectively.

Table (6): Blood glucose response, glucose index, and glucose load for processed bread from flour an extraction rate of 90% by adding ascorbic acid.

The type of flour and bread it is made from	Blood glucose response, mg/100ml					Area under the curve mg/ml/min	glucose		white bread	
	0	30	60	90	120		GIg	GLg	GIb	GLb
0 ascorbic acid (Extract 72%)	85	101	98	92	92	1220 b	67 b	34 a	97 a	48 a
ascorbic acid 5 ppm	81	90	95	91	86	1065 c	59 bc	30 b	86 b	43 a
ascorbic acid 10 ppm	85	102	105	84	82	1035 c	57 c	29 b	83 b	42 a
ascorbic acid 15 ppm	93	104	109	100	98	1095 c	60 bc	30 b	86 b	43 a
Whole meal flour 100%	92	103	106	100	97	1065 c	59 bc	30 b	86 b	43 a
white bread	91	101	109	102	100	1275 b	70 b	35 a		
standard glucose	88	122	113	94	79	1815 a	100 a			

The numbers represent the average of three replicates

Different letters in the same column mean that there is a significant difference ($P \leq 0.05$)

GI g and GLg glucose index and glycemic load, respectively, when standard food glucose is used.

GIb and GLb glycemic index and glycemic load, respectively, when white bread is used as standard food.

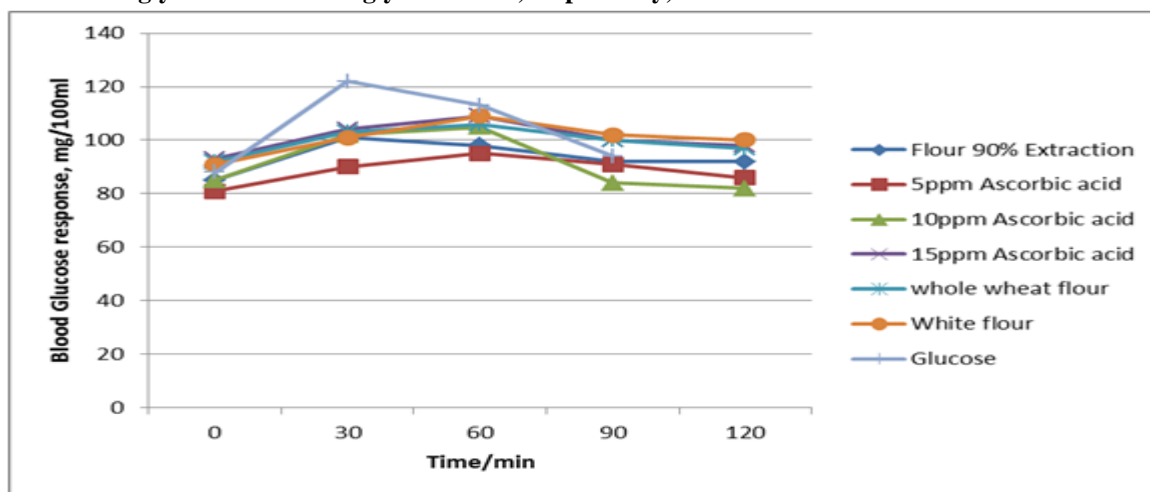


Figure (2) Blood glucose response to wheat bread made from 90% extraction flour by adding ascorbic acid.

As a result of the values obtained through blood glucose response, the glucose index reached 67, 59, 57, 60, and 59 for each of the control samples (bread flour extraction 90%) and for bread with 5, 10, and 15 ppm ascorbic acid and total bread, respectively, while the glucose load reached 34 and 30 And 29, 30 and 30, respectively, when using glucose as a standard diet with significant differences ($P \leq 0.05$) between the samples. When using white bread as a standard food, the glucose index reached 97, 86, 83, 86, 86, and the glucose load was 48, 43, 42, 43, and 43 for each of the control samples and bread added to it 5, 10 and 15ppm ascorbic acid and total bread, respectively, with significant differences ($P \leq 0.05$) between the samples. . It is noticeable that the glucose index and the glucose load decreased slightly (59 and 30, respectively) when adding 5ppm ascorbic acid and it decreased significantly ($P \leq 0.05$) to 57 and 29, respectively when adding and 10ppm, but these indicators slightly increased in the sample of bread added to it. 15ppm ascorbic acid, all when using standard food glucose. The saying also applies when white bread was used as a standard food (Table 8 and Figure 2). The decrease in the glycemic index due to the effect of adding ascorbic acid was more low for bread made from 90% extraction flour (67 to 57 by adding 10ppm ascorbic acid) than it was lower for 72% extraction flour (70 to 65 by adding the same amount of acid), despite this high The values are slightly lower (60 and 66, respectively) when the quantity is increased to 15ppm. The reason may be due to the increase in the proportion of dietary fiber as bran in it, which leads to the synergy of these two factors, not bringing about change. Also, the addition of ascorbic acid in regulated and limited quantities may lead to a lowering of the glucose index of bread made from extraction flour by 72 and 90% as well, as shown in Figure (3).

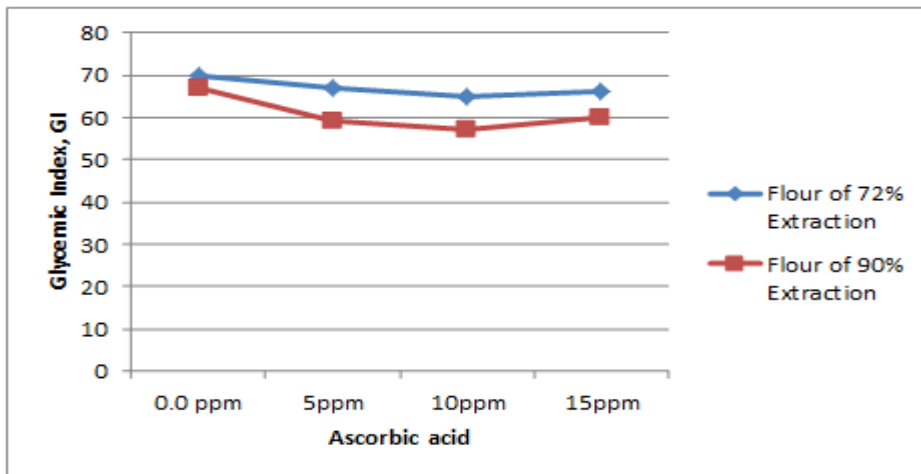


Figure 3: Effect of adding ascorbic acid on the glucose index of bread made from flour extracted

This effect occurred on the glucose index by increasing the concentration indirectly by affecting the properties of the dough and the resulting bread, especially the dough's hardness and flexibility through the formation of gluten nets. Vitamin C may also reduce the emulsifying properties and emulsification stability of gluten, increase gluten solubility, and improve gluten paste viscosity by altering the number of sulfur bonds in gluten and gluten reticulum formation (Jia et al., 2022). This in turn also leads to obstructing the breakdown of carbohydrates and starch in particular, which leads to a lowering of the glucose index in these limits of the concentrations used.

Reviewing by Simić et al. (2021) stated that improper concentrations (especially very high) can increase the dough resistance as well as reduce its elasticity, although the ideal concentration for bread improvement is between 50 and 70 mg/kg flour. They also mentioned that a wide range between 10 and 200 mg/kg of flour is also suitable. However, the effect of dough improvers depends not only on the amount added but also on the type of flour in which the dough is started as well as on the method of bread making (Šimurina et al., 2013 and 2014).

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