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Producing Baladi Bread from Wheat Substitute to Ensure Food Security in Egypt During the Russian-Ukrainian War

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ABSTRACT

Russian-Ukraine war showed reduction in global cereals index from 27% in 2021 to 14% in 2 months after the war. Since Egypt is the second largest wheat importer in the world and the food prices inflation increased from 17.7 to 37.3 (from February to December 2022), finding wheat substitute can achieve self-sufficiency for subsidized Baladi bread. The global and Egyptian situation analysis of food market before and during the crisis was presented.

The current study aimed to replace 20% of wheat flour (WF) (87.5%) (control) with barley, or corn, sorghum, rice, and quinoa, and evaluate rheological properties for dough, chemical composition, protein quality, and sensory acceptance of bread formula. Physical and texture properties for Baladi bread formulas were accepted and the nearest value to the Wheat flour bread (WF)B in sensory properties was Wheat/ rice bread (WF/RF)B, Wheat/ yellow corn bread (WF/YCF)B, Wheat/ barley bread (WF/BF)B, Wheat/ sorghum bread (WF/SF)B and finally was wheat/ quinoa bread (WF/QF)B. Addition of quinoa gave the highest fat, fiber, protein, and ash contents 1.45, 1.63, 13.92 and 1.78g/ 100g DM respectively. Essential amino acid index (EAAI%) were 60.62%, 57.41%, 56.49%, 51.96%, 48.15%, and 40% for (WF/QF)B, (WF)B, (WF/SF), (WF/BF)B, (WF/YCF)B, and (WF/RF)B respectively. The study recommends more research to correlate the possibility of the

expansion of crop mapping among different governorates to produce Baladi bread with different flour grains.
Keywords: Amino acid; Approximate analysis,Baladi bread, Cereals flour substitute,Rheological analysis,Russian-Ukrainian war.
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INTRODUCTION

Russia and Ukraine export about 33% of the world's wheat, 20% of yellow corn, and 80% of sunflower **(WFP, 2022)**. Therefore, sustaining food production systems and increasing food stocks will maintain the state of food security.

In order to improve agricultural productivity, several tackles are needed such as increasing soil fertility and technical adaptation, restricting insect diseases, redistribution of agricultural map in line with climate changes **(Ahmed et al., 2022)**, and restricting of urbanization at the agricultural land expanse **(Shi et al., 2022).**

All previous challenges led Egypt to be the second largest wheat importer in the world with approximately 50% of wheat demand, thereby, Russian- Ukrainian war strongly threatening Egyptian food security. **(CAPMAS, 2022)** indicates that food prices inflation was at a record high of 20% in March 2022; only a week after the Russian- Ukrainian war **(Abay et al., 2022)**. Any shock to the global markets by 1% will transmit a positive shock in the Egyptian wheat spot market for a high volatility regime **(Ahmed, 2022).** Therefore, future policies to increase food security require reducing the dependency on wheat imports.

The governmental role could be summarized through improving wheat storage, minimizing wheat losses, building silos controlled with artificial intelligence, and optimization of wheat by-products, developing a market information system to increase the competitiveness among all actors in the supply chain, and important to take proper logistic strategies to encourage farmers to compete in wheat producing **(Ahmed, 2022)**.

A number of thesis and research works have been published in Egypt to improve food self-sufficiency and achieve economic efficiency during normal food security conditions using wheat flour replacement with highly nutritive and economically cost-saving grains; such as corn, quinoa, barley, oat, mung bean types of flour with different replacement ratios for each **(Ahmed, Abu El- Yazid et al., 1998; Mahmoud, Ahmed, Mohamed, Ahmed, 2006; El-Sayed Sadek, Mohamed et al., 2015; Abdellatif et al., 2017; Laila A., Amina El-Sayed Teer, et al., 2020)**.

For identifying determinants of wheat consumption, irrigated agricultural and food security challenges in Egypt, **(Almas & Usman, 2021)** recommend policy makers and stakeholders for use other cereals as wheat substitute in order to achieve food security. The current study aimed to A) summarize the global and Egyptian situation analysis of main cereals under the Russian-Ukrainian war, B) Determine natural, technological, and nutritional characteristics, and sensory evaluation for 20% wheat flour replacement with some grain alternatives (barley, corn, rice, sorghum and quinoa) to produce Baladi bread in a trial to reduce wheat imports and contribute to self- sufficiency. Should state the aim of the study presented in the article and it should outline the essential background.

GLOBAL AND EGYPTIAN SITUATION ANALYSIS

Russian-Ukrainian war will increase poverty and hunger in many countries above 40 approximately million, especially with limiting coping capacity, highly depending on imports, rising transport, fuel, raw material costs in the Middle East/ North Africa (MENA) region and sub-Saharan Africa; therefore, food availability will be insufficient especially in some Middle East countries **(Oksana & Охріменко, 2022)**. The cases of food insecurity are estimated to increase by 4-6 million people in the MENA region starting from the beginning of the war. The percentage of annual FAO cereals index reduced from 27% in 2021 to 14% in 2 months after the war in 2022 **(WFP, 2022)**.

Figure 1) presents FAO's latest forecast for world cereal markets by MT before and after the conflict from 2ed mid-2018 to 1st mid-2023, comparing global production, supply, and utilization for global cereals.

In 2022, FAO forecasted a 1.3% reduction in cereal production, rice was the leading cause, it reduced from 524.4 to 516.6 MT in 21/22 and 22/23 respectively, followed by coarse grains (barley, sorghum, and maize) reduced from 1,508.7 to 1,462.5 MT in 21/22 and 22/23 respectively. On March/23 global cereal utilization forecasts a decline of 0.6% below 2021/2022; stemming from the reduction of coarse grains utilization by 1.4 MT in 2022/2023 compared to last year's counterpart. FAO forecasts world wheat consumption for 2022/23 rises by 0.8 %. FAOs forecast the reduction of global rice utilization by -0.26% below the 2021/22.

The world's cereal stocks-to-use ratio in 2022/23 decreased by 29.5% (844.3 MT) compared to 2021/22, resulted from the sharp downward revision to maize stock estimate to 344 MT (8.3 %) fall in world maize stocks compared to 2021/2022. FAO's forecast for global rice stocks at the end of 2022/23 has declined by 1.6 MT to 194 MT. FAO's global wheat inventory forecast for 2022/23 to raise from 293.8 to 306 MT in 2022/2023 above last year's, resulting from increases concentrated in China and the Russian Federation.

Figure 2: compare annual food and cereal price index before and during the Russian war using the FAO Food Price Index (FFPI) to determine the possible impact of global price changes on vulnerable developing countries using the main 5 food groups (cereals, meat, dairy, oil, and sugar).

FFPI averaged 125.6 points in 2023 with a sharp downward (10.67%) from 2022 140.6 points. The slight decrease in the FFPI in 2023 is due to substantial drops in the price indices of vegetable oils and dairy products, as well as slightly lower indices for cereals and meat. In 2023, the FAO Cereal Price Index averaged 141.8 points, a slight decrease (6.3%) from 2022's 151.3 points.

In January 2023, there was an increase in wheat prices on the world market (0.3%) that lasted until February. The price of corn increased by just 0.1 % globally from one month to the next. Sorghum prices globally were down slightly (0.2%) and barley prices marginally (0.9%) in February, in contrast to other coarse cereals. On the other side, in February, the price of rice decreased globally by 1.0 % **(Kandagatla & Almas, 2020)**.

Despite 3.6% of Egyptian land area is used for agriculture, it's contributing as the major economic sector (14.5%) of country's gross domestic production (GDP) **(Kandagatla & Almas, 2020**), which revised down to (12.3%) owing to the Russia-Ukraine war **(IHS Markit, 2022)**.

Egypt faces external and internal challenges; climate changes, Russian- Ukrainian war, and an increase in the foreign interest rate are the most external challenges, while the internal challenges could be summarized in overpopulation **(Heggy et al., 2021; Sayed, 2021)**, where the growing population rate of 1.7% in 2021 according to **(World Bank),** with food consumption pattern depending on cereal production, socio-cultural growth contribute to the volatility of food availability, water scarcity and its serious consequences **(Heggy et al., 2021)**, though crop fluctuation is a major issue in Egyptian agriculture, plays a role on varying market prices. Therefore, increasing the gap between consumption and population pushes the government to increase wheat imports. As a result of, population density pressure the predicting studies **(Almas & Usman, 2021)** indicate that wheat consumption will rise by 20, 30, and 46 MT for the years 2020, 2050, and 2100 respectively, to feed 100, 140, and 220 million Egyptian citizens respectively.

Table 1) presented the production/ton and cultivated area/ Feddan from studied cereals in (2017/2018) and during the Russian-Ukrainian war (2021/2022) according to the Egyptian Bulletin of Agricultural Statistical 2018- 2022 **(Economic Affairs Sector)**. The cultivated area increased for rice, sorghum, and wheat by round 34%, 31%, and 8% respectively, while the cultivated area for maize and barley were reduced by round -27% and -10% respectively, which were attributed to global increases of vegetable oil prices **(FAO)**, the Egyptian Ministry of Agriculture and Land Reclamation (MALR) planned to increase the cultivation of soya bean and sunflower.

The increased percentage of cultivated area for rice or sorghum was fourfold than wheat. Although, the cultivated area for barley reduced by -10%, the production quantity/ ton increased by 36% this suggested to the species of barley. Rice was the highest production by 38% followed by barley 36%, sorghum 28%, alternatively, wheat convergent increases values of 15%.

Table 2) presents wheat producer prices before and during the war according to the ministry of supply and interior trade. Assuming 2018 is the base year, Calculating the changes in PP using LCU (LE.)/Ton showed increases of 14%, 2%, 4%, 13%, and 03.11% from 2018 to 2023 from each previous year in a column respectively. On the other hand, calculating PP using $ as the average exchange rate for the Egyptian currency **(The World Bank)**; showed a downward in the value of PP ($/ ton) by -2% in 2022 compared with 2018. Actually, the data showed an increment in the PP ($/ ton) but at a falling direction from 2018 to the next years in the column till 2021 from 21%, 9%, and 4% respectively, then dramatical inflation in the Egyptian currency resulted in falling of PP from 308.76 $/ton in 2021 to 220.65 $/ton in 2022, with a changing by -28%. In 2023, the Egyptian government increases the PP to 10.000 LE./Ton, with increase by 83% compared with 2022 to encourage framers to increase wheat cultivation, resulting in enlarged the wheat price as calculated with $ to 325.20 $/Ton in 2023 compared with 220.56 $/Ton in 2022.

Figure 3) and 4) presented annual and monthly food Price Inflation (FPI), Figure 3) illustrated increase FPI from 13.29 in 2018 to 20.73 in 2022 (FAO). Figure 4) present the change% of monthly FPI during 2022. The increase of FPI was 17.7% and increased to 37.3% at Dec.2022 **(World Bank, 2023)**. **CAPMAS, 2022** interpret the inflation reasons to high commodity prices and traders' greed which resulted that 74% and 90% of households reduced their consumption of food commodities and animal protein food respectively, while 1.3% increased their bread intake during crisis.

As wheat considered as staple food for Egyptians, there were negative correlation between wheat consumption and its prices, furthermore, the GDP/ capita has a positive correlation with wheat consumption(Almas & Usman, 2021) in stable condition. The Consumer Price Index (CPI) is an economic and statistical indicator reflecting changes of commodities prices at retail market for its importance to inflation measure. CAPMAS reported **(CAPMAS, 2023)** that the food and beverage index number (FBIN) was 149.7, considering that 2018/2019 was the base year (before the crisis). The % of change in FBIN declined from 37.9% in December/ 2021 to 4% in November/2022, this predicts on increasing wheat’s demand, as **(Almas & Usman, 2021)** proved that increasing CPI correlate negatively with wheat consumption.

MATERIALS AND METHODS

Materials:

Wheat flour 87.5% extraction rate used for making subsidized Baladi bread was obtained from South Cairo Mills Co. Giza, Egypt. Rice flour (RF) and yellow corn flour (YCF) purchased from the local market. Barely, sorghum, and quinoa seeds were obtained from Horticultural Research Institute- Agricultural Research Center (ARC).

Methodology:

Flour Preparation for sorghum, barely and quinoa

Removal of impurities from seeds (kernels, foreign materials, broken kernels) has been done using Carter Dockage Tester. For quinoa seeds, dehulling scale 60_{sec} (DQS_{60s}) was used ***(*****Gomaa *****et al.*****, 2019)**. Seeds were dried on 55◦C for 2 hours then grounded into flour and sifted in dough department in FTRI using sieve diameters 45 mish/ 1 inch2= 355 micron.

The Coding for studied flour samples were as follow: wheat flour extraction 87.5% (WF); wheat flour+20% barely flour (WF/BF), wheat flour +20%sorghum flour (WF/SF), wheat flour + 20% yellow corn flour (WF+YCF), wheat flour + 20% rice flour (WF/RF) and wheat flour + 20% quinoa flour (WF/QF).

Baladi bread preparation

Six doughs for Baladi bread with different studied cereal samples were prepared according to **(Sallam *et al*., 1995)** in the experimental bakery of FTRI.

Rheological analysis:

Farinograph test of dough used to prepare different types of bread were done according to **(AACC, 2000)** was made using Brabender Duis G, type 810105001 No. 941026 made in West Germany. Percentage of water absorption, arrival time (min), dough development time(min), dough stability (min) and degree of softening (B.U.) were determined.

Extensograph test method described in the **(AACC, 2000**) using Extensograph (Barabender Duis Bur G type 860001 No. 946003 West Germany) to measure dough extensibility (mm), dough resistance to extension (Elasticity) using Barabender units, proportional number, dough energy (using planimeter in cm^3), dough extensibility (mm), configuration rate of the different tested formula, and proportion number (P.N.).

Texture Profile Analysis (TPA) was carried out by using Brookfield CT3 instrument (Brookfield Engineering Laboratories, Inc., MA 02346-1031, USA) according to the method outlined in the (AACC, 2010) which was modified for flat bread by using a small-scale holder TA-JPA fixture for punching through bread samples with maximum 12.7 mm diameter probe. Prior to testing, bread loaves were cut carefully into quarters, and each was used of the experimental at zero time. Penetration was applied at two points of each bread quarter avoiding non-representative areas. The following test settings were used: Target = 8.0 mm, Trigger load = 1.50 N, Test speed = 2.00 mm/s, Return Speed = 2.00 mm/s and # of Cycles = 2.

The following TPA characteristics were determined: firmness (average of two cycles), and gumminess as described in the operating instruction manual.

Sensory Evaluation

After cooling the baked Baladi bread samples organoleptic evaluation was conducted by twenty panelists from FTRI staff members. Crumb and crust attribute were evaluated as described by **(Kemp et al., 2009)** with modification in the score of studied characterizations. Taste (20), order (20) appearance (15), Layers separation (15), crumb texture (15), crust color (15) and overall acceptability (100) were countered.

Approximate chemical analysis, amino acid and protein quality evaluation

The approximate chemical composition for flour and Baladi bread formulas were made in (RCFF). according to **(A.O.A.C., 2012)**, protein were determined using kjeldahl KJ8400 method no. 984.13 Ch.(4) described by**(A.O.A.C., 2019)**. Carbohydrate (CHO) content was calculated by difference. Energy value (kcal/100 g Dry Matter (DM)) = (protein in g × 4) + (CHO in g × 4) + (fat in g × 9).

Essential amino acid (E.AA) and non-essential amino acids (N.E.AA) were determined according to the method described by**(A.O.A.C., 2012)**. Protein quality assessment of the studied formulas were calculated using AA score and using egg AA pattern as reference protein according method of **(Sarwar et al., 1985)**. Essential Amino Acid Index EAAI% was calculated according to **(Mente et al., 2002)**, using the AA pattern of whole egg protein **(Hidvegi & Bekes, 1984)** as reference protein.

Statistical analysis:

The collected data were statistically analyzed using variance by the least significant differences (L.S.D) at the $P<0.05$ level of probability procedure **(McClave *et al.*, 1996)**.

RESULTS AND DISCUSSION

Approximate analysis for flour blends study:

Approximate analysis for different flour formulas (table, 3) demonstrate that WF used as control registed the lowest fat and energy contents 0.75g/100g DM and 377 Kcal/ 100g DM respectively similar to **Punia *et al.,2022* (Laila A., Amina El-Sayed Teer, et al., 2020)**, and agreed with (**Soliman *et al.,2019);* (Punia et al., 2022)** in chemical composition and were close resemblance to **(El-Fadaly, 2015)**.

WF/RF recorded the lowest fiber, protein and ash contents 0.03, 9.50 and 0.56 g/100g DM respectively, WF/QF registed the highest fat, fibers and protein 1.85, 2.68 and 16.53 g/100g DM **(Soliman et al., 2019)**, as quinoa is known as the highest source of protein compared to other cereals, Dehulling quinoa seed(DQS_{60s}) reduce protein, fat, fiber and ash contents from quinoa seeds **(Gomaa et al., 2019)**.

WF/BF recorded the highest fiber and ash contents 1.87 and 2.22 g/100 g DM respectively compared with WF and WF/QF which were similar to **(Laila A., Amina El-Sayed Teer, et al., 2020)**.

Rheological properties of flour blends:

Farinograph properties for Blends flour formula:

For bread-making rheological properties of dough are important for a final product quality. Bread dough parameters (water, salt content and mixing time) and the complex nature of gluten with combination of viscous and elastic properties composite rheological properties of the dough and predict the quality of the final product **(Keentok et al., 2002)**.

Data in table 4, revealed the effect of replacing WF with 20% of previous mentioned cereals flour on farinograph properties. It could be noticed that WF/BF and WF/QF formula resulted in increased water adsorption to 62.7% compared with WF 60.5%, **(El-Fadaly, 2015)**, this could be related to higher contents in protein and fibers as table (3) in WF/BF and WF/QF than WF.

Table 4) proved that inversely correlation between stability and dough softening. Replacing WF with QF and SF resulted in reducing elasticity in WF/QF **(Abdellatif, 2017)** and WF/SF with 310 and 340 respectively. Data proved positive correlation between stability and energy (which reflect total area under the Extensograph curve).

The dough stability time slightly decreased for WF/BF, WF/SF, WF/YCF and WF/RF replacement of WF while the WF/QF showed the lowest dough stability time compared with WF, vice versa the lowest dough softening was noticed by WF; that mean negative correlation between stability and softening characteristics. The replacement of WF by cereals flour resulted in increase of dough softening, these results may be attributed to that flour of cereals are gluten free.

Extensograph properties results for studied flour formula:

In table 4) maximum dough elasticity recorded by WF/BF followed by WF/RF and WF+YCF, while the minimum elasticity was recorded for WF/SF. The high dough extensibility (120 mm) was recorded for WF**(Prem et al., 2022)** followed by WF/BF and WF/RF (90 and 80 mm) respectively, while the minimum extensibility was recorded WF/YCF = 65 mm. The best dough's energy recorded by WF followed by WF/BF dough while the WF/SF and WF/QF had minimum energy.

From the above-mentioned data, it could be noticed that the replacing of wheat flour by different cereals flour resulted in slight effect on farinograph properties (stability time) except for WF/QF formula, the great reduction of stability time was recorded. The maximum value of degree of softening was WF/ QF (110 B.U), while the minimum value recorded by WF (20 B.U), while other studied cereals flour doughs ranged between 30 to 50 B.U. From Extensograph properties the best replacement of WF were BF followed RF, SF, YCF and QF.

Physical properties for Baladi bread formula:

Data in table 5) illustrated the physical properties of studied Baladi bread. The moisture content of bread ranged from 36.95 to 38.64%, while the water activity ranged from 0.931 to 0.945which agreed with Egyptian standardization of bread No. (1419/2006). Moisture% and water activity in the control (WF)B were 37.42% and 0.934 respectively, both parameters reduced with replacement in loaves of (WF/BF)B **(El-Fadaly, 2015)** and (WF/QF)B.

The ascending order for layer separation characteristics of Baladi bread were WF (control) 0.75%, followed by (WF/RF)B, (WF/BF)B, (WF/YCF)B, (WF/SF)B and (WF/QF)B, this result attributed to different properties of starch granules and fiber contents of studied cereals.

Texture properties for Baladi bread:

Data in Table 6) represents texture properties for Baladi bread formula. The hardness values ranged from 17.02 to 25.25 N. Replacing WF with other cereals lead to lowering the hardness of the loaves. This related to the increase gluten in WF compared with other cereals formula, and on the other hand, the feeling of bran particle size made mouth feeling more gritty **(Mollakhalili-meybodi et al., 2022)** and hardness compared to other cereals bread formula; therefore, (WF)B showed the highest hardness value as (25.25N) along with the lowest cohesiveness and springiness 0.80 and 8.95 mm respectively. Texture on WF depend on gluten content, while on other formula it is depending on gluten and viscosity of cereals starch, which cause different feeling in the mouth during chewing; it resulting more cohesiveness **(Mollakhalili-meybodi et al., 2022)**. (WF/YCF)B showed the lowest hardness texture (17.02 N). On the opposite, replacing WF with other cereals lead to increase the cohesiveness of other studied bread **(El-Fadaly, 2015; Soliman et al., 2019)**. In the same direction springiness increased with the replacement of WF with other cereals.

(WF/RF)B showed the highest cohesiveness, springiness, gumminess and chewiness texture properties, this attribute to starch granule of rice is higher viscosity compared to other used cereals' starch significantly and higher starch content 89.1 g/100g DM comparing with other types of Baladi bread formula **(Hussein et al., 1977)**.

Sensory parameters for Baladi bread formula:

As the total acceptance reflects the sum of all other sensory parameters,it reflects the same direction for the rest of sensory parameters. The statistical analysis revealed that (WF)B showed the best preferences for all sensory parameters, and total acceptance, formation of a viscoelastic gluten network, gives (WF)B the unique texture, **(Mollakhalili-meybodi et al., 2022)** proved that WF extraction less than 87.5% improve the quality and sensory parameters for baked bread. The nearest value to the (WF)B were (WF/RF)B, (WF/YCF)B, (WF/BF)B, (WF/SF)B and finally was (WF/QF)B, this means that it was less accepted for all sensory parameters. The smell parameters didn't show any differences for all cereal Baladi bread formula.

Approximate chemical analysis for Baladi bread formula:

Data in table 8) presents approximate chemical composition of Baladi bread. The statistical analysis didn't show any significant differences between bread formulas in DM weight, while the rest of the parameters showed significant differences.

(WF/QF)B showed the highest fat, fiber, protein and ash. **(Soliman et al., 2019)**, **(Abdellatif, 2017)** found that quinoa replacement to 30% increased protein, ash, lipid and fiber than control when compared with the other replacement percentage. Fat contents of (WF/QF)B agreed with **(Laila A., Emad M., et al., 2020)**. Statistical analysis didn't show any significant differences in fat content between (WF/QF)B and (WF/YCF)B (1.45 and 1.43 g/100g DM respectively). (WF/BF)B recorded close value of protein content to (WF/QF)B 13.28 and 13.92 g/100g DM. (WF/RF)B registered the lowest fiber, protein and ash contents 0.9, 10.32, and 1 g/100g DM.

Amino acid contents in Baladi bread formula:

AA contents in bread formula were presented in 9) as cereals is source of plant protein; therefore, N.E.AA is higher than E.AA in all studied Baladi bread formula. Total E.AA contents in all bread formula were lower than reference egg over 32-44.5%. (WF/RF)B showed the lowest E.AA. On the contrast (WF/QF)B was the highest in both E.AA. and N.E.AA 33.81 and 65.97 AA g/16 g N. TNEAA for all tested formula were almost doubled than TEAA.

E.AA: (WF)B or the control was the highest in Aromatic AA, cysteine and sulfuric E.AA 7.05, 3.77 and 5.41 AA g/16 g N respectively. (WF/BF)B showed the lowest threonine, valine, Isoleucine, leucine and lysine contents 2.41, 3.92, 3.09, 5.72 and 2.33 g/16 g N respectively. (WF/SF)B showed the highest leucine 4, 2.25 g/16 g N. (WF/YCF)B showed the lowest tyrosine 0.6 g/16 g N. Meanwhile, (WF/RF)B recorded the lowest phenylalanine, aromatic AA, cysteine, methionine, sulfuric and total E.AA (4.10, 4.46, 2.87, 1.51, 4.38 and 27.60 g/16 g N respectively). (WF/QF)B registed the highest threonine, valine, iso-leucine, phenylalanine, lysine, methionine and total E.AA (3.2, 4.65, 3.97, 4.94, 2.91, 2.03, 33.81 g/16 g N respectively), **(Abdellatif, 2017)** who studied (WF/QF)B with 30% quinoa was rich in 10 AA Threonine, valine, tyrosine, isoleucine, leucine, phenylalanine, histidine, lysine, cysteine and methionine contents.

N.E.AA: (WF)B showed the lowest serine 3.03 g/16 g N. (WF/BF)B recorded the lowest alanine, aspartic, glycine and arginine (3.01, 4.59,3.39 and 3.99 g/16 g N respectively. (WF/SF)B recorded the highest in alanine 4.34 g/16 g N. (WF/RF)B recorded the lowest glutamic, proline, arginine and total N.E.AA (23.28, 7.98, 1,72, and 53.61 g/16 g N) respectively. (WF/QF)B recorded the highest aspartic, serine, glutamic, glycine, proline, arginine and total N.E.AA (6.10, 4.26, 29.06, 4.17, 10.95, 5.04 and 65.97 g/16 g N respectively).

Chemical prediction of protein quality indexes for Baladi bread formula:

Data from Table 10) predict the pattern of protein quality through determining EAAI% and limiting first, AA as nor CS.

EAAI estimates protein quality depending on the EAA contents compared with egg reference AA. It is a rapid method to evaluate optimize the AA content of food. The descending order for EAAI percentage for studied Baladi bread formula were (WF/OF)B, (WF)B, (WF/SF)B, (WF/BF)B, (WF/YCF)B and(WF/RF)B. In this respect (WF/QF)B showed the highest EAAI percentage it showed the highest CS values and digestibility compared with other studied Baladi bread formula in lysine, tyrosine and cysteine, followed by (WF)B.

Lysine, tyrosine, methionine, and cysteine were the main limited AA in cereals **(D'Mello, 2011; Millward, 2012)**. As cereal were a high source of proteins and limited in lysine therefore, it should pursued this need with lysine supplementation or replacement with adequate amount of animal protein in human nutrition**(Millward, 2012)**. Lysine and tyrosine were the first limited CS in studied Baladi bread formula.

From all-above mentioned, it could be recommended that the best ranking for flour types used to Baladi bread were BF, RF, YCF, SF, QF respectively, while all cereal flours were accepted to replace WF for Baladi bread processing. Also, all Baladi bread types were accepted according to their physical, texture, sensory, and nutritional properties so, we could use all cereal flours substitutes depending on agriculture plan' needs.

Figures and Tables:

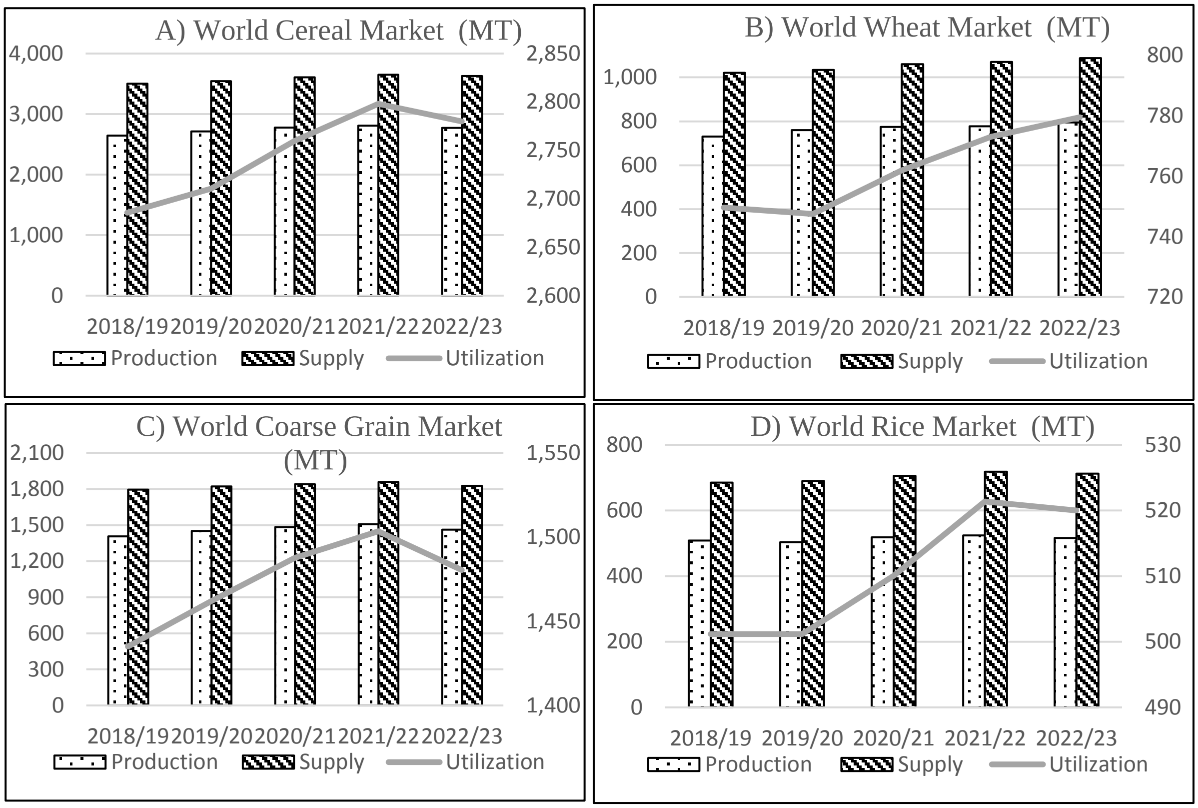

Figure 1: World Trade Market before and after the conflict

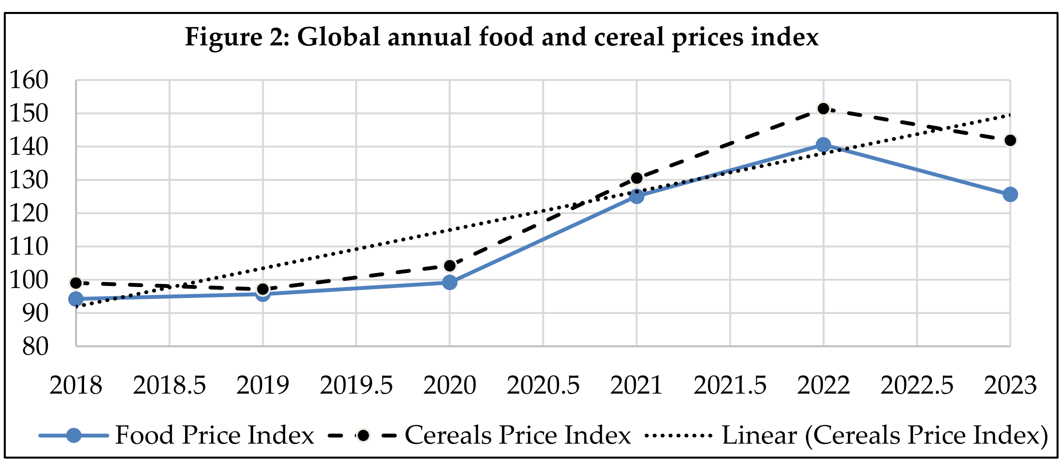

Figure 2: Global annual food and cereal prices index.

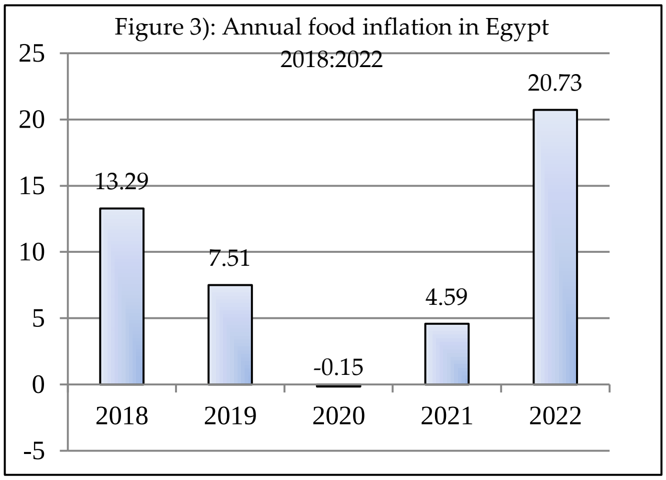

Figure 3): Annual food inflation in Egypt 2018:2022

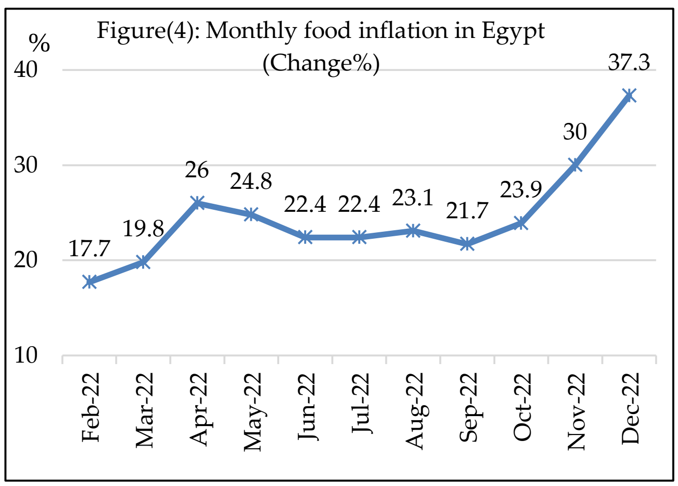

Figure (4): Monthly food inflation in Egypt

Table 1: Production and cultivated area of main studied cereals in Egypt

Crops	Production/ton			Cultivated area/ Feddan		
	2017/2018	2021/2022	% Change	2017/2018	2021/2022	% Change
Wheat	8,348,629	9,623,167	15%	3,157,765	3,417,023	8%
Maize	7,428,718	5,551,744	-25%	2335625	1,716,556	-27%
Rice	3,121,857	4,300,574	38%	858,742	1,149,427	34%
Sorghum	802,128	1,030,410	28%	368,722	482,600	31%
Barley	84,206	114,846	36%	273,738	245,673	-10%

Table 2: Wheat Producer price (PP) in Egypt

Year	(LE./ Ton)	Change (LE/ Ton)	Average Exchange rate "$"	($/Ton)	Change %
2018	3996	-	17.77	224.87	-
2019	4562	14%	16.77	272.03	21%
2020	4662	2%	15.76	295.81	9%
2021	4829	4%	15.64	308.76	4%
2022	5461	13%	24.76	220.56	-29%
2023	10000	83%	30.75	325.20	47%

Table 3: approximate analysis for studied flour formula (gm/100 g. DM) (mean ± S.E.)

Item	WF	WF/BF	WF/SF	WF+YCF	WF/RF	WF/QF	LSD 0.5
DM	88.60±4.75^a	89.2± 2.28^a	90.50±0.66^a	89.60±1.86^a	90.50 ±1.24^a	92.30 ±1.88^a	7.627
Fat	0.75±0.04^c	1.22±0.13^bc	1.21±0.17^bc	1.72±0.14^ab	0.82 ± 0.15^c	1.85 ±0.26^a	0.495
Fiber	1.36±0.32^c	1.87±0.03^b	1.56±0.11^bc	0.82± 0.08^d	0.03 ± 0.01^e	2.68 ±0.11^a	0.465
Protein	10.85 ±0.5^b	11.48±0.29^b	11.52±0.46^b	9.73±1.37^c	9.50 ± 0.85^c	16.53 ±0.58^a	1.113
Ash	1.00±0.09^bcd	2.22 ±0.47^a	1.75±0.39^abc	0.80±0.22^cd	0.56±0.09^d	1.90 ±0.31^ab	0.924
CHO	81.69±0.91^b	83.21±0.51^b	83.96±0.94^b	86.93±1.36^b	89.09±0.76^a	77.69±1.83^c	3.499
Energy (Kcal)	377 ±1.55^c	390±2.45^b	393 ±2.23^b	402±1.19^a	402± 0.65^a	391 ± 1.67^b	6.403

Each value represents the mean ± S.E (Standard Error). Values in the same row with the same letter aren't significant at P.≤ 0.05.

WF: wheat flour | BF: Barley flour | SF: Sorghum flour | YCF: Yellow corn flour | RF: Rice Flour | QF: Quinoa flour

Table 4: Farinograph & Extensograph parameters of wheat flour and its formula

Code	Farinograph parameters					Extensograph parameters			
	water absorption%	Arrival time (min)	Dough development (min)	stability (min	Softening degree (B.U.)	Elasticity (B.U)	Extensi-bility (mm)	P.N.	Energy (cm2)
WF	60.5	1.5	2.5	13.5	20	360	120	3.00	50
WF/BF	62.7	1.5	4	12.5	30	430	90	4.77	40
WF/SF	58.4	2.5	6	11	50	310	75	4.13	25
WF/YCF	58	2.5	6.5	11	50	350	65	5.38	20
WF/RF	59	1.5	3.5	11	50	400	80	5.00	35
WF/QF	62.7	1.5	5.5	8	110	340	70	4.85	20

WF: wheat flour| BF: Barley flour| SF: Sorghum flour| YCF: Yellow corn flour | RF: Rice Flour | QF: Quinoa flour

Table 5: Physical properties for studied Baladi bread formula

Code	Hardness (N)	Cohesi veness	Springiness (mm)	Gumminess (N)	Chewiness (mg)
	Zero time				
(WF)B	25.25	0.80	8.95	22.11	197.9
(WF/BF)B	19.12	1.01	9.12	19.18	175.0
(WF/SF)B	17.70	1.08	9.96	19.14	190.7
(WF/YCF)B	17.02	0.98	8.96	15.02	164
(WF/RF)B	19.03	1.17	10.52	22.20	235
(WF/QF)B	19.46	0.99	9.72	20.08	195

(WF)B: wheat bread | (BF)B: Barley bread| (SF)B: Sorghum bread | (YCF) B: Yellow corn bread| (RF)B: Rice bread| (QF)B: Quinoa bread

Table 6: Texture properties for studied Baladi bread formula

Code	Moisture %	water activity (0 time)	Baladi bread Weight (g)			
			Weight of loaf	Upper layer	lower layer	% of layer separation
(WF)B	37.42	0.934	125.55	54	71.55	0.75
(WF/BF)B	37.21	0.931	125	52.35	72.65	0.72
(WF/SF)B	36.95	0.935	125.97	51.78	74.19	0.69
(WF/YCF)B	37.32	0.945	117.64	49.18	68.46	0.71
(WF/RF)B	38.64	0.943	123.16	52.48	70.68	0.74
(WF/QF)B	37.25	0.931	124.69	49.98	74.71	0.69

(WF)B: wheat bread | (BF)B: Barley bread| (SF)B: Sorghum bread | (YCF) B: Yellow corn bread| (RF)B: Rice bread| (QF)B: Quinoa bread.

Table 7: Sensory evaluation of the Baladi bread formula

Sensory parameters	(WF)B	(WF/BF)B	(WF/SF)B	(WF/YCF)B	(WF/RF)B	(WF/QF)B	LSD $_{0.05}$
Taste (20)	18.65± 0.2^{a}	18.45± 0.27^{a}	18.1± 0.28^{ab}	18.2±0.37^{ab}	18.25±0.49^{ab}	17.15±0.6^{b}	1.141
Color upper layer (15)	14.05± 0.14^{a}	13.5± 0.4^{ab}	13.37±0.19^{ab}	13.75± 0.16^{a}	14.0 ± 0.18^{a}	12.72 ±0.4^{b}	0.777
Layers separation (15)	14.45± 0.16^{a}	13.0± 0.44^{b}	13.27 ± 0.25^{b}	13.97 ± 0.21^{ab}	13.85 ± 0.21^{ab}	13.12 ± 0.45^{b}	0.906
Crumb texture distribution (15)	14.35± 0.17^{a}	12.65± 0.40^{bc}	12.12± 0.27^{c}	13.09± 0.48^{bc}	13.55 ± 0.18^{ab}	12.12 ± 0.35^{c}	0.965
Oder (20)	18.3± 0.24^{a}	18.3± 0.38^{a}	17.40 ± 0.29^{a}	18.20 ± 0.20^{a}	18.10 ± 0.22^{a}	17.80 ± 0.34^{a}	0.856
T. appearance (15)	14.8± 0.28^{a}	13.17± 0.24^{bc}	13.05 ± 0.40^{bc}	13.92 ± 0.21^{ab}	13.97 ± 0.18^{ab}	12.57 ± 0.42^{c}	0.953
T. acceptance (100)	94.6± 0.72^{a}	89.07± 1.64^{bcd}	87.32 ± 0.97^{cd}	91.14 ± 0.99^{abc}	91.72 ± 0.96^{ab}	85.5± 1.92^{d}	3.721

Average of total acceptance was converted to a descriptive category i.e.: V. Good: 90–100, Good: 80–89, Acceptable: 70–79, Poor: less than 70 Means of the row followed by the same letter are not significantly different ($p < 0.05$) from each other, where a: is the highest value and d: is the lowest whereas **b,c:** are moderate

(WF)B: wheat bread | (BF)B: Barley bread | (SF)B: Sorghum bread | (YCF) B: Yellow corn bread | (RF)B: Rice bread | (QF)B: Quinoa bread.

Table 8: Approximate analysis for studied bread (gm/100 g. DM) (mean ± S.E.):

Item	**(WF)B**	**(WF/BF)B**	**(WF/SF)B**	**(WF/YCF)B**	**(WF/RF)B**	**(WF/QF)B**	**LSD $_{0.5}$**
DM(gm)	62.58±2.65^{a}	62.79±2.28^{a}	63.05±2.35^{a}	62.68±1.30^{a}	61.36±2.10^{a}	62.75± 2.12^{a}	6.607
Fat	0.95±0.06^{b}	1.08 ± 0.06^{ab}	1.33± 0.28^{ab}	1.43± 0.12^{a}	0.92± 0.11^{b}	1.45± 0.07^{a}	0.434
Fiber	1.23±0.05^{abc}	1.39 ± 0.28^{ab}	1.42± 0.11^{ab}	1.03± 0.08^{bc}	0.90± 0.11^{c}	1.63± 0.14^{a}	0.453
Protein	12.21±1.48^{ab}	13.28 ±1.17^{ab}	11.5± 1.27^{ab}	11.65± 0.55^{ab}	10.32±0.85^{b}	13.92± 0.74^{a}	2.981
Ash	1.2± 0.3^{a}	1.38 ± 0.26^{a}	1.68± 0.13^{a}	1.25± 0.14^{a}	1.0±0.19^{a}	1.78± 0.42^{a}	0.721
CHO	84.41 ±0.88^{abc}	82.87 ±0.85^{bc}	84.08± 1.50^{abc}	84.65± 0.60^{ab}	86.87± 0.82^{a}	81.22± 0.83^{c}	2.989
Energy **(KCAL)**	395±2.50^{ab}	394±1.03^{b}	394±1.33^{b}	398±1.07^{a}	397±0.79^{ab}	394±1.32^{b}	3.317

Each value represents the mean ± S.E (Standard Error). Values in the same column with the same letter aren't significant at P.≤ 0.05.

(WF)B: wheat bread ∣ (BF)B: Barley bread∣ (SF)B: Sorghum bread ∣ (YCF) B: Yellow corn bread∣ (RF)B: Rice bread∣ (QF)B: Quinoa bread

Table 9) Amino Acid (AA) content g/16 g N in Baladi bread formula:

AA profile	AA g / 16 g N						Egg AA reference
	(WF)B	**(WF/BF)B**	**(WF/SF)B**	**(WF/YCF)B**	**(WF/RF)B**	**(WF/QF)B**	
Essential amino acids (E.AA)							
Threonine	2.54	2.41	3.13	2.92	2.73	3.20	5.1
Valine	4.26	3.92	4.61	4.29	3.95	4.65	6.8
Iso- Leucine	3.44	3.09	3.74	3.43	3.31	3.97	6.3
Leucine	6.31	5.72	7.73	6.87	5.89	7.17	8.8
Tyrosine	2.54	2.64	1.56	0.60	0.36	2.03	4.2
Phenylealanine	4.51	4.22	4.78	4.55	4.10	4.94	5.7
Aromatic AA	**7.05**	**6.85**	**6.34**	**5.15**	**4.46**	**6.97**	**9.9**
Lysine	2.62	2.33	2.69	2.83	2.87	2.91	7
Cysteine	3.77	3.24	2.95	3.26	2.87	2.91	2.4
Methionine	1.64	1.58	1.82	1.80	1.51	2.03	3.4
Sulfur AA	**5.41**	**4.82**	**4.78**	**5.07**	**4.38**	**4.94**	**5.8**
Total E.AA	**31.62**	**29.14**	**33.02**	**30.57**	**27.60**	**33.81**	**49.7**
Non-Essential amino acids (N.E.AA)							
Alanine	3.36	3.01	4.34	3.78	3.31	3.87	-
Aspertic	5.49	4.59	6.08	5.92	5.82	6.10	-
Serine	3.03	3.09	4.08	3.43	3.16	4.26	-
Glutamic	27.61	25.98	28.68	26.45	23.28	29.06	-
Glycine	3.77	3.39	3.74	3.78	3.88	4.17	-
Proleine	9.58	9.11	10.25	9.19	7.98	10.95	-
Histidine	2.54	1.88	2.17	2.23	1.72	2.52	-
Argenine	4.34	3.99	4.17	4.12	4.46	5.04	-
T.N. E.AA	**59.72**	**55.05**	**63.52**	**58.90**	**53.61**	**65.97**	
Total AA	**91.34**	**84.19**	**96.54**	**89.47**	**81.20**	**99.78**	

(WF)B: wheat bread | (BF)B: Barley bread | (SF)B: Sorghum bread | (YCF) B: Yellow corn bread | (RF)B: Rice bread | (QF)B: Quinoa bread

Table 10: Protein evaluation of the Baladi bread formula

	(WF)B	(WF/BF)B	(WF/SF)B	(WF/YCF)B	(WF/RF)B	(WF/QF)B
EAAI (%)	57.41	51.96	56.49	48.15	40.10	60.62
Amino acid score (CS)						
First	Lysine	Lysine	Tyrosine	Tyrosine	Tyrosine	Lysine
	37.45	33.35	37.24	14.31	8.55	41.53

(WF)B: wheat bread∣(BF)B: Barley bread∣ (SF)B: Sorghum bread∣ (YCF) B: Yellow corn bread∣ (RF)B: Rice bread∣ (QF)B: Quinoa bread

CONCLUSION

Russia and Ukraine export about 33% of the world's wheat (55 million Tons), 20% of yellow corn, and 80% of sunflower. Russian- Ukrainian war will exacerbate the acute food insecurity prospection, giving that the repercussions of the war on food, energy, fertilizers- prices, and supply.

Cereal is the main food for Egyptian population, and grains represent 65% from total food imports. Egyptian government aimed to raise wheat self-sufficiency rate to 80% through increasing wheat production by 8% were taken, to reach 1 million Feddan by 2030. At the same time, several actions regarding food accessibility to confront the crisis and mitigate its impact on families; 1) Granting additional supply incentives for local wheat price; 2) Free unsupported bread loaf pricing, 3) moratorium on export of a number of products, most notably cereals, and 4) exceptional support disbursed on catering cards in amounts ranging from 100 to 300 L.E. for 6 months from 1/9/2022 **(CAPMAS, 2022)**.

In Egypt, rice, corn, sorghum, and barley are used as substitutes for wheat with less elastic demand for wheat, food prices inflation was at a record high of 20 percent in March 2022; only a week after the Russian-Ukrainian war. The cultivated area during the period of 2018 to 2022 has increased for rice, sorghum, and wheat by about 34%, 31%, and 8% respectively, which reflected in increasing the production quantity by 38%, 28%, and 15% respectively. While the production quantity of barley increased by 36% despite of decreasing the cultivated area by 10%.

The current study demonstrated that 20%sibstitute of Baladi bread wheat flour by barley, sorghum, yellow corn, rice, and quinoa flour were technologically feasible(rheological, and physical characteristics). All bread formula were accepted from taste, color, odor and appearance. From nutritional point of view all bread formula the statistical differences were accepted in chemical composition, protein quality.

Current study recommends the following:

1) As quinoa can be grown in a variety of soil pH levels, and withstand many pressures such as salinity, cold air, intense sun radiation, nighttime temperatures below freezing, arid and semiarid regions, lowlands, brackish plains, salt-water marshes, and high-altitude with various agricultural lands, recommendation should be directed to expand its cultivation on new desert areas and new delta especially that it's need of water is limited compared with other cereals.

2) studying the correlation of agricultural inputs for studied cereals according to the challenges facing agriculture sector in Egypt or during the different crisis conditions.

3) Modifying the agricultural map for different cereals using artificial intelligent and Geographic information system (GIS).

4) Collaborative between different ministries and sectors and research centers to reduce dependency on wheat import.

5) Conducting nutrition education programs for modifying the consumption pattern for Egyptian consistent with food habits and crisis conditions.

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إنتاج الخبز البلدي من بدائل القمح لضمان الوصول للأمن الغذائي لمصر خلال الحرب الروسية الأوكرانية

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بناء علي التقرير السنوي لمنظمة الأغذية والزراعية فإن الحرب الروسية الأوكرانية أدت إلي انخفاض مؤشر الحبوب العالمي من 27% في 2021 إلي 14% خلال شهرين بعد الحرب مباشرة. وبما أن مصر تعتبر ثاني أكبر مستورد للقمح وحد أن معدل التضخم للغذاء ارتفع من 17.7 إلي 37.3 من فبراير إلي ديسمبر 2022 علي التوالي. اهتمت الدراسة الحالية باستعراض الوضع العالمي والمحلي لسوق الحبوب والغذاء قبل وأثناء أزمة الحرب الروسية الأوكرانية. الحكومة المصرية زادت الكمية المنتجة من الشعير، الأرز، السورجم والقمح بمقدار 38%، 36%، 28% و15% علي التوالي بينما تم خفض الكميات المنتجة بالذرة وذلك في مقابل زيادة المساحات المنزرعة من فول الصويا وعباد الشمس وذلك للتغلب علي الإرتفاع الرهيب في السعر العالمي للزيوت.

اهتمت الدراسة الحالية إلي استبدال 20% من دقيق القمح (WF) استخراج 87.5% كمجموعة ضابطة بكل من الشعير أو الذرة أو السورجم أو الأرز أو الكينوا لإنتاج خلطات من الخبز البلدي. تم إجراء تقييم الخصائص الريولوجية للعجائنوالتحليل الكيميائي لخلطات الدقيق ،كما تم قبول الخصائص الفيزيقية والملمس للخبز البلدي وبالنسبة للخواص الحسية كان الأكثر قبولا للخبز البلدي المصنوع من القمح (WF)B كان الخبز البلدي المدعم بالأرز (WF/RF)/Bيليه بالذرة الصفراء (WF/YCF)/B يليه الشعير (WF/BF)/B يليه السورجم (WF/SF)/B وكان الخبز المدعم بالكينوا (WF/QF)/B أخرهم قبولا حسيا بينما كان هو الأعلى في المحتوي الكيميائي من الدهون والألياف والبروتين والرماد حيث سجل 1,45 و 1,63 و 13,92 و 1.78 جم/ 100 جم وزن جاف علي التوالي. وكانت النسبة المئوية لمؤشر الأحماض الأمينية كان 60,62% و 57,41 % و 56,49% و 51,96% و 48,15% و 40% لكل من خبز البلدي المدعم بكل من الكينوا والقمح والسورجم والشعيروالذرة الصفراء والخبز علي التوالي. أوصت الدراسة الحالية بالعديد من الأبحاث لربط إمكانية التوسع في الخريطة الزراعية لمختلف المحاصيل في مختلف المحافظات لإنتاج خبز بلدي بخلطات حبوب مختلفة علي حسب التوزيع الجعرافي للحبوب.

الكلمات الكاشفة: الأحماض الأمينية ، التقييم الكميائي، الخبز البلدي ، بدائل دقيق القمح الخصائص الريولوجية ، الحرب الروسية الأوكرانية .