Ain Shams University
Faculty of Specific Education
Home Economy Department

Functional properties of some gluten- free products for People with celiac

By

Hoda Mohamed Hanafi Ahmed

Assist. Lecturer in Home Economics Dept., (Nutrition and Food science)
Faculty of Specific Education
Fayoum university

Thesis Submitted for Partial Fulfilment of the Requirements

of phd. Degree in Home Economic Dept.,

(Nutrition & Food Science) Faculty of Specific Education. Ain Shams university

Under the supervision of:

Dr. Sahar Soltan Abdel Magied
Prof. of Nutrition
Former Head of Hom Economic Dept and
Vice Dean for Grduate Studies and
Research Fac. of Specific Education
Fayoum University

Dr. Samah Mohamed Ismeal
Prof. of Food Sci. & Nutrition
Former Head of Hom Economic Dept
Fac. of Specific Education
Ain Shams University

Dr. Reda Abd El- Naby
Lecture of Food Sci. & Nutrition
Hom Economic Dept
Fac. of Specific Education
Ain Shams University

Dr Mahmoud Abd Al Hamid El Wakeel
Lecture of Food Science
Food Science and Technology . Dept.
Fac. of Agricultural
Beni Suif University

2020

6.SUMMERY

6.1. Physicochemical properties of tested sample

- **Saponin analysis**

The result showed that quinoa seeds contain saponin was (0.035%) and after washing and soaking was (0.022%). So, it is in the acceptable range according to **Koziol, (1992)** who reported that, quinoa was categorized as "sweet" being saponin free on with <0.11% saponin on a fresh weight basis or "bitter" with >0.11% saponins. **Gomez-Caravaca *et al.*, (2011)** mentioned that, the content of saponins ranged from 5.6 to 7.5% of the total composition of whole quinoa flour.

- **Chemical composition of corn, quinoa and millet flours**

Corn flour had the highest percentage of moisture (6.86%), while quinoa was (5.41%) and millet being (4.87%). On the other hand, millet flour have the highest percentage of ash (4.86%) followed corn (4.26%) and quinoa has the lowest percentage of ash (2.97%). The highest percentage of fat was 9.72% in corn followed by millet 7.9% and quinoa 6.55%.

Quinoa and millet are worthy of consideration as an important grain source of protein being 15.10 and 12.50% in dry matter, respectively while corn was (9.20%). Results also indicated that no significant differences ($p>0.05$) among the corn, quinoa and millet samples in carbohydrates (69.94, 69.95 and 69.84%) respectively. Starch is an important part in carbohydrate, results showed that corn was (41.29%), quinoa (46.97%) and millet was (43.85%).

- **Amino acids**
- **Essential amino acids**

The highest amount of essential amino acids was Leucine which had a value of 9.89% dry matter in corn followed by millet (9.76%) then quinoa 8.42%. While the lowest one was Methionine which represent 2.85%, 2.24% and 2.17% in quinoa, millet and corn respectively. Quinoa recorded the highest value of Lysine (5.30%) comparable to corn and millet. Millet generally contain significant amounts of essential amino acids particularly the sulphur containing amino acids methionnine and cycsteine (2.87 and 3.60), respectively comparing with quinoa and corn.

- **Non-essential amino acids**

Millet recorded the highest values of non-essential amino acids such as Alanine, Asprtic, ½Cysteine and Glutamic acids (8, 8.08, 3.60 and 19.44%) respectively. Also in total non-essential amino acids millet was the highest value 54.8% followed by corn was 52.85% then quinoa (50.57%). While, quinoa recorded the highest value in total essential and semi essential amino acids 32.93 and 12.72% respectively

- **Mineral (Macro and micro elements)**

Potassium (K) had the highest value of the three samples followed by magnesium (Mg) and calcium (Ca) had the least value of samples among the macro-elements. Quinoa recorded the highest results of minerals, iron (4.47), calcium (82.78), magnesium (169.55) and potassium (1508.64 mg/100g).

Millet takes the second level of minerals with 3.99, 72.59 and 157.69 mg/100g of iron, calcium and magnesium respectively.

- **Vitamins**

Quinoa seeds have more vitamin C, Nicotinic and Pyridoxin (67.34, 224.27 and 97.33ppm respectively) followed by corn then millet (8.01, 103.86 and 38.97 ppm) and (7.64, 66.17 and 35.42ppm) respectively.

Vitamins soluble in fat (Vit. A and Vit.E) are found to be the highest ratio in corn followed by quinoa then millet (391.7885 and 40.48049 µg/100g), (294.4231 and 11.71329 µg/100g) and (115.6823 and 8.333006 µg/100g) respectively.

6.2. Physical properties of tasted flouer samples

- **Bulk density**

The highest loose porosity values were found for 25%Millet+50%Quinoa+25%Corn samples was 0.483 g/cm3. While the corn sample was the highest value in the tapped density of 0.830 g/cm3 followed by 75% Millet + 25% Corn (0.770 g/cm3) and the difference was 0.375 and 0.344g/cm3 respectively.

The lowest differences between loss and tapped bulk density were found in 75%Q+25%C (0.209 g/cm3) followed by 25% M+75% Q (0.225 g/cm3).

- **Water holding capacity (WHC) and Wettability**
- **Water holding capacity (WHC)**

The obtained results show that water holding capacity WHC is increased in (25% quinoa +75% corn) was 0.87 g/g DMB followed by (50% millet + 25% quinoa + 25% corn) 0.72 g/g DMB as seen in Fig (5). While the samples (75% millet + 25% quinoa) and (25 % millet+ 25% quinoa+50% corn) were recorded the lest values 0.66g/g DMB comparing with the control 100% corn 0.71g/g DMB. On the other hand, these results suggested that dietary fibers from all samples containing quinoa with corn in different ratios (70 g/g) could aid gel formation and enhance texture stability of food products such as bread and other baked products. In contrast, low WHC of samples containing quinoa with millet ranged between 66-69 g/g DMB may be due to the damage of fiber matrix and the collapse of the pore during grinding

- **Wettability**.

the highest wettability was (50% Millet+25% Quinoa+25%Corn) 4.46 S and on the contrary 25%Millet+75%Quinoa recorded the lowest wettability 2.88 S. Typically, the increase wettability time for sample was associated with an increase in wettability in all samples from 3: 4 S in all tested sample.

- **Fat absorption capacity**

Fat absorption capacity (FAC) ranged from 2.39 to 5.17g/g oil, when the PS was >500µm, and it was between 2.05 to 3.41 when PS was reduced to < 160 µm .As shown from the previous illustration, increased PS is associated with increasing FAC Cf shows the lowest FAC compared with the other three dietary fiber (DF) sources i.e. Pk, D and Ps. Even though, these DF sources can be used to aid in stabilizing emulsions of the food systems, as well as being a good source of DF.

6.3. Instrumental analysis

- **Thermal properties**

Thermal analysis includes Differential Scanning Calorimetry (DSC) and thermogravimetric analysis (TGA).

- **Differential Scanning Calorimetry (DSC)**

Onset temperature (T0) of all the tested samples ranged from 27.41 to 319.42 ºC, the peak gelatinization temperature (Tp) was the highest one (331.47 ºC) in (75%Millet+25%Corn sample) followed by (25%Quinoa+75%Corn sample) (329.44 ºC), in contrast, the peak gelatinization temperature which was only 71.07 ºC was observed in the peak 1 in 75%Millet+25%Quinoa sample, compared to the other tested samples.

- **Thermogravimetric Analysis (TGA)**

The thermogravimetric curves of the tested samples presented the first event of the thermal decomposition at temperature intervals from 62.33 to 120.5ºC for 75%Quinoa+25%Corn and 50%Millet+25%Quinoa+25%Corn , respectively , while the75%Millet+25%Quinoa presented high temperature as much as 103.5 ºC.

The percent weight loss in the third stage in the tested samples, ranged from 295.6 to 303.07 ºC. This stage show the highest level of loss during decomposition. Stages except 50%Quinoa+50%Corn and 25%Quinoa+75%Corn recorded two stages.

The 25% Quinoa+75%Corn. sample recorded the biggest weight loss was 83.643 at 301.34 ºC while the 75%Millet+25%Quinoa showed the smallest the weight loss 53.28 at 298.96 ºC

The tested sample showed the residue at 600 ºC from 13.64 to 5.35 at 25%Millet+25%Quinoa+50%Corn and 25%Millet+50%Quinoa+25%Corn, respectively. On the other hand the samples 25%Millet+75%Quinoa, 75%Quinoa+25%Corn, 50%Millet+25%Quinoa+25%Corn and 100%Corn come into view nearly 12.5 %

6.4. Dough properties

- **Mixolab**

Mixolab is a new instrument developed by Chopin Technologies Company and the information related to its utilization on different aspects of wheat flour quality, as far as the author is aware is quite limited. It has the capabilities to measure physical properties of dough like dough strength and stability, and to assay the pasting properties of starch on actual dough. Furthermore, it is used to characterize the rheological behavior of dough subjected to a dual effects, mixing and temperature. It measures in real time the torque (Nm) produced by mixing of the dough between the two kneading arms.

6.5. Sensory evalution

- **Sensory characteristics of biscuits**

(100% corn) sample had the highest value in all parameters and over all acceptability was (87.2±9.8) compared to other tested samples followed by 25%Q +75% corn then 75%Q +25% C over all acceptability was 74.3±9.6 and 71.4±8.6 respectively. While there were no significant differences in samples (25% Millet+25% Quinoa+50% Corn) and (25% Millet+50% Quinoa+25% Corn) in surface character and mouth feel were and they recorded the lowest values, the over all capacity of them was 58.3±11.5 and 59.3±8.2 respectively.

- **Sensory characteristics of cookies**

The maximum scores were obtained for control (100% Corn) which had the highest value in all parameters and over all acceptability (93.3±5.1) followed by gluten free cookies prepared from (25% Quinoa+75% Corn) followed by (25% Millet+75% Corn) over all acceptability was (74.4±10.8 and 70.8±8.9) respectively.

There was no significant difference in overall acceptability in samples {(25% Millet+75% Corn), (25% Millett+75%Quinoa), (50% Quinoa+50% Corn), (50%Millet+25% Quinoa+25% Corn), (75% Millet+25% Corn), (50% Millet+50% Corn), (25%Millet+50% Quinoa+25% Corn) and (50% Millet+50% Quinoa)}by { 70.8±8.9, 70.0±5.4, 69.1±9.0, 69.0±9.4 ,

68.7±10.7, 68.3±6.7, 66.9±6.9 and 65.5±7.4} respectively. The results also indicated that the sample (25%Millet+25% Quinoa+50% Corn) had the lowest value of overall acceptability (63.3±7.9).