Production of Greek yoghurt with quinoa flour

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ABSTRACT:

Greek yoghurt is distinguished from conventional yoghurt by its particular flavour and consistency. Compared to normal yoghurt, it has more total solids and less lactose. This research sought to fortify Greek yoghurt with vegetable solids while strengthen stability and improving the texture without the use of commercial stabilisers. Accordingly, the current study assessed the impact of adding quinoa flour to Greek yoghurt at ratios of 1, 2, 3, 4, and 5% w/w on physicochemical characteristics and the product's organoleptic evaluation. Results showed that addition of quinoa flour to the Greek yoghurt mixture increased the viability of bacteria and decreased the incubation period. The viscosity of stored Greek yoghurt was dramatically increased as a result of the fortification quinoa flour. The sensory analysis of Greek yoghurt with all ratios except the ratio of 5% quinoa flour did not significantly affect the acceptability scores. Quinoa flour added to the Greek yoghurt led to enhance its rheological characteristics. The outcomes demonstrated that quinoa flour had a favourable impact on Greek yoghurt's capacity to contain water and syneresis. The findings suggested that adding quinoa flour to Greek yoghurt enhanced the physical, chemical, and organoleptic qualities up to a 4% addition rate.

Keywords: Greek yogurt; Quinoa flour; Fermentation; Microstructure.

INTRODUCTION:

Yoghurt has developed into a unique product over the past several years due to consumers' inclination for a healthy lifestyle that includes eating more nutrient-dense meals as well as their liking for yoghurt itself (Schmidt et al., 2001). One of the dairy industry's fastest-growing products is Greek yoghurt. Greek yoghurt, sometimes referred to as strained yoghurt since the whey is removed during the straining process, keeps the distinctive, sour flavour that is typical yoghurt while possessing a more dense texture. Regarding sensory qualities, Greek yogurt's texture characteristics are also crucial. Greek yoghurt should contain a minimum protein level of 5.6%, as comparied to normal yogurt's which contain 2.7%, even though there is no legal necessity for this (Desai et al., 2013). Greek yoghurt typically contains 20.5–24.6% total solids, 6.4–10.7% total fat, 8.2–10.4% total protein, 1.1–1.3% minerals, and a pH range of 3.67–4.05. It also typically contains 2–3 times as much fat and protein as traditional yoghurt, as well as 50% more minerals and a higher concentration of viable microorganisms. According to Nsabimana et al., (2005), GY has great creaminess, insignificant syneresis, a slight acidity of 1.80–2.00%, and a low lactose level of about 6% . Greek yoghurt is produced using a variety of ways, ranging from simple to complex. Traditional, laborious procedures include separating whey using fabric bags. These increase the need for better techniques to be developed, such as "wheyless process" using dried milk, concentrated milk protein, or concentrated whey protein (Kashaninejad et al., 2019). Since plant proteins are abundant and affordable sources of protein and calories, such as oat protein concentrate or its isolate and lentil flour, they have been used to enhance the nutritional value and protein content of many food products in recent years(Zare et al., 2011), (Joung et al., 2016), (Akin and Ozcan, 2017), and (Brückner-Gühmann et al., 2019). Therefore, this research aims to fortify Greek yogurt with one of the distinguished grains to obtain a product of high nutritional and sensory quality. The protein composition of quinoa, a dicotyledonous pseudo-grain, ranges from 13% to 20%, while the starch content is 48% to 69% (Elsohaimy et al., 2015; Sezgin and Sanlier, 2019).Quinoa seeds have a high nutritional value, a high content of essential amino acids, and a protein quality that is comparable to whole dry milk (Ng et al., 1994).Due to its high nutritional value, Quinoa (seed/flour) has the potential to be a great source for creating functional foods that have health-improving properties. (Curti et al., 2017; Obaroakpo et al., 2020) Due to its remarkable nutritional value and ability to reduce the risk of many diseases, quinoa seed has grown in popularity as a significant food resource in the pharmaceutical and industrial sectors (Filho et al., 2017). The majority of the carbohydrates in quinoa seeds, 52 g/100 g of starch, make up the majority of the seed's dry bulk. The superior technological characteristics of quinoa starch, such as its higher amylograph viscosity, greater capacity to bind water, and swelling power, set it apart from the starch of other seeds (Lorenz, 1990). Additionally, because the grains of quinoa starch are so small and stable, they can be utilised as an alternative to starches that have undergone chemical modification (Sharma et al., 2015). In addition, quinoa seeds have unsaturated fatty acids, primarily linoleic (52%) and oleic (25%) acids (Ruales and Nair, 1993). According to Zhang et al., (2014), it also contains tocopherols and carotenoids, which are lipophilic molecules with significant antioxidant and antiradical activity. Potassium, calcium, magnesium, phosphorus, sulphur, iron, and zinc are the most significant mineral components of quinoa seeds (Kozioł, 1992; Konishi et al., 2004). Quinoa seeds also have a high vitamin content, particularly those of the group B (B1, B2, B3, and B6). Quinoa is abundant in additional bioactive compounds such as phenolic acids, flavonoids and tannins that have antioxidant activities and potential health benefits (Kozioł, 1992; Jahaniaval et al., 2000; Vega Galvez et al., 2010; Repo-Carrasco-Valencia and Serna, 2011; Tang et al., 2015). The effect of fortifying Greek yogurt with different levels of quinoa flour on some properties was evaluated:

manufacture of Greek yogurt with different ratios (1, 2, 3, 4 and 5%) of quinoa flour.

Study the chemical, microbiological, and rheological properties as will as sensory evaluation for Greek yogurt samples.

Study the microstructure of Greek yogurt samples by TEM.

MATERIALS AND METHODS

Fresh Cow's Milk (3.4 % fat, 3.12 % protein, and 8.5 %) and fresh Cream (40 % fat) were obtained from Al-Enmaa Farm, Juhayna Co., Egypt. Quinoa seeds were obtained from Abu Auf Company, Cairo, Egypt (Quinoa flour: 6.07% fat, 14.29 % protein, 1.96% Ash, and 94.7 % total solid). Milk protein concentrate (0.5% fat, 79 % protein, and 94.5 % total solid), and Skim milk powder (1.25% fat, 34% protein, and 95.64% total solid) were provided from juhayna Co. (October 6, Egypt). Commercially available lyophilised culture (FD-DVS YoFlex® Premium 6.0) was supplied by Chr.Hansen Laboratories (Copenhagen, Denmark).

Preparation of quinoa flour

Quinoa flour (QF) was prepared as described by Herrera et al. (2019). as shown in Fig. (1).

Production of Concentrated yogurt (Greek)

Concentrated yogurt samples were made as previously described by (Tamime, 2008; Mehanna et al., 2018; Alkobeisi et al., 2022) with some modifications. The total solids content of milk was standardized to (22%) by combining with Skim milk powder: Milk protein concentrate (1: 7.7 w/w). This milk was used to produce fortified Greek yogurt treatments with different levels of QF (1%, 2%, 3%, 4% and 5%) and the control sample without QF. To do this, the powders were dispersed in milk using a lab mixer at low speed for 30 minutes, followed by storing the milk for 1 hour at 4 °C to allow for complete hydration. Then, the fat content of the milk samples was standardized to 6% by adding cream. Then, samples were preheated to 55 °C and homogenized (Pilot + CC02, GEA, Germany) at pressure: 150 bar First stage: 130 bar Second stage: 26 bar. The homogenized milk was pasteurized at 92 °C for 15 minutes and then cooled to 42 °C in an ice water bath. Starter culture (FD-DVS YoFlex® Premium 6.0, Chr. Hansen) consisted of Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgraicuss was added at a 1% to the samples then the inoculated samples were incubated at 43 °C until pH reached (4.7). Finally, all transactions were stored at 4 °C until analysis.

Chemical analysis

Total solids, fat, crude protein, total dietary fiber, and ash contents of Greek yogurt samples ware estimated according to the AOAC (2016). The carbohydrate content was calculated using the formula [carbohydrates = 100% −% (moisture + ash + crude protein + fat)] (FAO/WHO, 1998).

Microstructure observations

The microstructure of yoghurt samples was examined using transmission electron microscopy (JEOL JEM-1400 TEM series 80kV, USA). The method of Garcia-Risco et al. (2000) was used for the yoghurt sample preparation.

pH and total titratable acidity

The pH values of the sample were measured with a pH meter (MetrohmAG, Herisau, Switzerland) at 25℃. The titratable acidity was determined based on a method introduced by Zannini et al., (2018).

Susceptibility to Syneresis

The syneresis extent of the samples was monitored after the complete fermentation (i.e., 24 h). Twenty grams of the yoghurt was spread on the surface of Whatman filter paper (number 1) and placed on a Buchner funnel. In the next step, the funnel was attached to an Erlenmeyer flask which was previously connected to a vacuum pump. The yoghurt sample was then filtered under vacuum for 10 min, and the filtrate was weighed (Supavititpatana et al., 2008).

The syneresis value was then calculated as follows: $\text{Syneresis (\%)} = \frac{\text{Filtrate(g)}}{\text{Initial weight of yogurt(g)}}$

Water-holding capacity (WHC)

WHC of yoghurt sample was determined by the centrifuge method. The yogurt sample (10 g) was added to a tube and then stored at 4℃ for 24 hr. Afterward, the tube was centrifuged at 5000 g for 10 min at 4℃. The whey separated from the samples was weighed for WHC measurement According to the method described by (Ilyasoğlu et al., 2015). The WHC was calculated as follows :

WHC =(wt/wi)× 100,

where wt is weight (g) of the pellet and wi is initial weight(g) of the sample.

Apparent viscosity

The apparent viscosities of the samples were determined using a Brookfield rotational viscometer (DV2TRVTJ0, Brookfield, Middleboro, MA, USA) according to the method described by Alkobeisi et al. (2022).

Microbiological analysis

Lactic Acid Bacterial lactic acid bacterial count (LAB) counted by using MRS agar medium according to the methods described in the FIL/IDF Standard (117A/1988).

Determination of antioxidant activity (DPPH)

DPPH scavenging activity of the stable 1,1-diphenyl2-picrylhydrazyl (DPPH) radical of Greek yogurt sample extracts was determined according to the procedure based on Brand-Williams et al. (1995) and standards of quercetin were prepared in methanol solution for reaction with the DPPH free radical. Two milliliters of 0.15 mM DPPH were added to 1 ml of extracts in different dilutions. A control was prepared by adding 2 ml of DPPH to 1 ml of methanol. The contents of the tubes were mixed and allowed to stand for 30 min, and absorbance was measured at 517 nm using a spectrophotometer (JASCO, Corporation Model V-730, S.N. A112961798, Tokyo, Japan). Triplicate tubes were prepared for each extract. The results were expressed as % radical scavenging activity as follows:

% DPPH radical scavenging = (A control − A sample)/ A control x 100

Sensory evaluation

Samples were served by thirteen panelists from the staff members at the Dairy Science Department, Faculty of Agriculture, Al-Azhar University, Egypt. The quality rating scorecard was used for the evaluation of flavour (60 points), body and texture (20 points), acidity (10) and colour & appearance (10 points) according to El-Shafei et al., (2020.(

Statistical analysis

The data were analyzed by a general linear model procedure (GLM) using SAS statistical analysis software package (SAS Procedure Guide 'Version 6.12 Ed.' SAS Institute Inc, Cary, 2004). The statistical analysis was performed using two-way analysis of variance (ANOVA). Means were compared by Duncan's test at the significance level of (P ≤ 0.05). Pearson's correlation coefficient was used to calculate the correlation.

RESULTS AND DISCUSSION

Chemical composition (%) of Greek yogurt fortified by quinoa flour:

The chemical composition of all concentrated yogurt treatments are presented in Table 1. The results showed that there was a significant difference (P ≤ 0.05) between the control sample and the rest of the treatments in terms of TS content, protein, Ash and carbohydrate contents. These results agree with what he mentioned El-Shafei et al., (2020). The TS content gradually increased with an increasing proportion of quinoa flour in the treatments, likely due to the ability of quinoa starch to bind water. Radi et al., 2009) said due to quinoa starch's high capacity to bind water, it may retain some bound water when milk is pasteurized and starch becomes gelatinized, preventing it from evaporating and ultimately increasing the total solids of yoghurt. According to the findings, there was a significant difference (P≤0.05) in the direction of acidification during yoghurt fermentation between the control sample and the treatments enriched with quinoa flour by 2%, 3%, and 4%. This difference can be seen in fig(2). By adding more quinoa flour to the treatments, the amount of time needed for fermentation gradually decreased. After 30 min of incubation for QF-4 (pH = 6.09) against control (pH = 6.42) and after 1 h for QF-3 (pH = 5.73) versus control (pH = 6.13), this effect was significant. for QF-2 (pH = 5.23) against control (pH = 5.31) after two hours.in comparison to control (pH = 4.97) after three hours for QF-1 (pH = 4.89). For yoghurts QF-2, QF-3, and QF-4, it took 3.5 hours to attain pH 4.7, compared to 4 hours for QF-1 and control. Our results are largely consistent with the findings of the researchers (Zare et al., 2012), who discovered that altering the carbohydrate composition of milk enhances the acidification rate of yoghurt starters. Since QF-2, QF-3, and QF-4 samples had the greatest levels of carbohydrates.

Changes in acidity and pH values during storage:

After fermentation, the pH of the yoghurt samples was roughly around 4.7. Typically, after 21 days of storage, the greatest acidity value was determined (Figure 3A). After 21 days of storage, the pH of all yoghurt samples decreased, from 4.7 to 4.36 (Figure 3A). According to Casarotti et al., (2014), this may be due to lactic acid fermentation during storage which cause an increase in acidity.

Viability of lactic acid bacteria in of Greek yoghurt with quinoa flour.

Lactic acid bacteria (LAB) activity may be responsible for the supplemented samples' quick decrease in pH and quick increase in titratable acidity. As opposed to this, Quinoa contains vitamins, minerals, amino acids, fermentable sugars, and fibre, all of which may increase the activity of LAB (Gordillo-Bastidas et al., 2016). Similar behaviour was seen by Codina et al., (2016), who reported that cow's milk yoghurt samples with added quinoa flour displayed a much higher pH decrease and significantly higher acidity increase throughout the fermentation duration as compared to non-supplemented samples.

Viscosity:

Greek yoghurt sample with quinoa (4%) presented apparent viscosity was much higher than that of the other samples (Table 2). Because starch granules can build a stronger protein network by dispersing and filling the gel network, the viscosity of the yoghurt formulation increased as the starch content increased. Furthermore, starch raises the protein concentration in the continuous phase, solubilizes amylose, absorbs water (during swelling), and enhances the viscosity of the continuous phase (Agyemang et al., 2020). These findings agreed with the adhesiveness observations, which are also used to predict viscosity (Anbarani et al., 2021). The apparent viscosity of all samples increased as the shear rate increased during the storage period. This could be due to the acidic pH of the end product (Demirci et al., 2018), This is not compatible with (Vieira et al., 2019) stated tha proteolytic enzymes generated by starter cultures in yoghurt weakening the protein network.

Syneresis:

In terms of the synergy value, the results showed a significant difference (P≥ 0.05) between the control sample and the treatments enriched by 2%, 3%, and 4% with quinoa flour. In all of the treatments, the lowest synergy value was measured. The value of synergy decreased for these samples as compared to the control sample. The harder texture of the QF-4, QF-3, and QF-2 treatments is probably what accounts for their lower syneresis rating. In addition, because starch and fibre have a propensity to bind water, their presence in QF may reduce the amount of free water molecules (James, 2009). The value of syneresis increased with storage period in all samples. According to deAlmeida et al., (2018), this is a result of casein network rearrangements brought on by acidity fluctuations during storage. Yoghurts containing QF may have starch retrogradation over the storage period, which could exacerbate the undesirable occurrence of syneresis (Agyemang et al., 2020). According to Zhu et al., (2020), the A-type polymorph and tiny polygonal granules of quinoa starch contain 17.1% amylose and 89.9% amylopectin. Wadchararat et al., (2006) claim that the interaction between leached amylose and amylopectin chains increased the level of syneresis over the course of storage

Water-holding capacity (WHC):

As the proportion of quinoa flour in the samples increased, as can be shown in Figure 4B, WHC generally increased significantly. The QF-4 sample 61.33% has the highest WHC concentration. The kind and concentration of the protein are most likely responsible for the higher WHC in the QF-4 sample compared to other samples. However, quinoa proteins' interactions with milk proteins through electrostatic, heat-induced hydrophobic, and covalent contacts might improve their functional qualities (Considine et al., 2011). On the other hand, it is obvious that the rise in WHC in the QF-4 sample can be linked to the system's rising starch ratio and the gelatinization that follows.

Microstructure

In this investigation, TEM was used to capture differences in the assembly of casein micelles in produced yoghurt. According to TEM micrographs, the yoghurts containing quinoa flour had a more compressed microstructure than the control, with the starch seeming to be surrounded by aggregated protein particles and occupying the open space with varying diameters inside the casein particle network (Figure 6).This outcome was in line with what Haque and Aryana (2002) had discovered. Additionally, casein micelles tended to gather and unite into double linear clusters in the matrix of yoghurt made with quinoa flour at a concentration of 3 g/100 g. of addition filled in the spaces between at this level. This finding was consistent with the findings of El Shafei et al., (2020). Addition of 3% (w/w) QF (QF-3) resulted in a more compact and robust gel structure. This could be because the carbohydrate ratio in the mix has increased. proteins allow them to create connections with starch molecules through hydrophilic groups.(Goel et al., 1999). According to the findings of texture and viscosity studies (Lin et al., 2017; Diamantino et al., 2019), starch works as a filler compound in the protein matrix and increases gel strength. Furthermore, in some areas, casein clusters and network pores were covered by quinoa starch. Other researchers also reported the formation of a smooth coating by polysaccharides on the casein network structure (Kalab et al., 1975;Erturk et al., 2021).

Sensory evaluation:

The effect of adding quinoa flour at Greek yogurt on flavour, body and texture, acidity as well as colour and appearance of yogurts are presented in table 4. Data show that supplementing Greek yogurt with quinoa flour enhanced the sensory attributes of yogurts. This result is probably due to the enhancement in the growth of starter culture, which increases the production of lactic acid and other flavour compounds. Also, yoghurts with quinoa flour showed acceptability for flavour at all supplementation level. As shown in Table 4, the effect of cementation of QF on the sensory qualities of concentrated yogurt, cementation added to the formulation in amounts more than 4%QF significantly decreased the level of appearance approval. This is supported by the colour change resulted and visual inspection of the product, which may be attributable to the samples developing a less palatable flavour and losing brightness as compared to the control sample. According to James (2009) and Lai et al. (2013), this was most likely brought on by the quinoa seeds' saponin being destroyed during the fermentation process. The control sample was ultimately less well received than the QF-2, QF-3, and QF-4 samples. The rejection of QF-5 sample by the sensers However, flavouring yoghurts with QF may increase consumer approval of the finished product in cementation of more than 4%QF (w/w).

CONCLUSION:

This research aimed to fortify Greek yoghurt with vegetable solids while enhancing the stability and improve the texture without needing to industrial stabilizers. So, the quinoa flour was used at ratios of 1, 2, 3, 4 and 5 % for this goal. According to the findings, The yoghurt's rheological properties were improved by the inclusion of quinoa flour, which also had a positive impact on syneresis and water-holding ability. It could be concluded that raising the total solids content of Greek yoghurt by adding up to 4% of quinoa flour may be the best option without compromising product quality and sensory characteristics.

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Table 1: Table 1. Chemical composition (%) of Greek yogurt fortified by quinoa flour.

Treatments	Fat	Protein	Carbohydrate	Ash	Total solid
Control	6.02 ±0.1^{a}	8.911±0.2^{a}	7.18±0.2^{a}	0.629±0.03^{a}	22.73±0.5^{a}
QF-1	6.08 ±0.3^{a}	9.045±0.1^{b}	7.93±0.05^{b}	0.637±0.02^{a}	23.71±0.4^{b}
QF-2	6.14 ±0.2^{a}	9.179±0.3^{b}	8.71±0.2^{bc}	0.795±0.01^{b}	24.83±0.3^{c}
QF-3	6.20 ±0.2^{a}	9.313±0.5^{bc}	9.61±0.1^{c}	0.929±0.02^{c}	26.05±0.7^{d}
QF-4	6.26 ±0.3^{ab}	9.457±0.5^{bc}	10.18±0.2^{c}	0.964±0.02^{c}	26.86±0.5^{de}

*Control: concentrated yogurt without QF, QF: concentrated yogurt with QF substituted at levels of 1, 2, 3, and 4% Values with different letters are significantly different at (P ≤ 0.05).

Table 2: Effect of fortification of concentrated yogurt by QF on the viscosity.

Storage (days)	Viscosity (cp)				
	Control	QF-1	QF-2	QF-3	QF-4
Fresh	2790 ±10.0^{a}	1720 ± 8.0^{a}	3860 ± 5.0^{a}	4630 ± 7.0^{a}	5094 ± 8.0^{a}
10	3050 ± 9.0^{b}	1818 ± 8.0^{b}	4517 ± 11.0^{b}	5411 ± 6.0^{b}	5673 ± 7.0^{b}
21	3350 ± 8.0^{c}	1883 ± 5.0^{c}	5150 ± 10.0^{c}	6183 ± 9.0^{c}	6250 ± 8.0^{c}

*Control: concentrated yogurt without QF, concentrated yogurt with QF substituted at levels of 1%, 2%, 3%, and 4%, respectively. Values with different letters are significantly different at)P ≤ 0.05(.

Table 3: Antioxidant activity of Greek yogurt produced by using Quinoa flour.

Treatments	Results % DPPH inhibition
Control	37.52 ±1.35
QF-1	39.18 ±1.35
QF-2	42.08 ±1.52
QF-3	43.97 ±1.61
QF-4	45.77 ±1.73

* Control: concentrated yogurt without QF, QF: concentrated yogurt with QF substituted at levels of 1%, 2%, 3%, and 4%.Pantothenic acid; 50 mg vit. Biotin; 50000 mg Zn; 60000 mg Mn; 30000 mg Fe; 10000 mg Cu; 1000 mg I; 100 mg Se and Co 100 mg.

Table 4: Sensory evaluation of Greek yogurt fortified by quinoa flour.

Sensory attribute	Score	Treatments					
		Control	1%Qf	2%Qf	3%Qf	4%Qf	5%Qf
Flavour	60	41.7±5.9^{a}	49.2±7.6^{c}	50.6±6.5^{c}	46.7±3.9^{b}	44.2±6.7^{a}	39.4±5.0^{a}
Body and Texture	20	13.3±3.8^{b}	14.5±4.2^{b}	15.9±3.1^{b}	15.2±3.9^{b}	13.9±3.6^{b}	11.9±3.3^{a}
Acidity	10	8.9±0.9^{b}	8.8±0.8^{b}	8.5±0.9^{b}	9.2±2.0^{b}	8.5±1.1^{b}	7.6±1.1^{a}
Colour & Appearance	10	8.7±0.9^{b}	8.2±0.9^{b}	8.6±0.9^{b}	8.4±1.2^{b}	7.2±0.6^{a}	7.1±0.8^{a}
Total	100	72.6±5.4	80.7±6.3	83.6±6.1	79.5±4.5	73.8±6.9	66±5.6

* Control: concentrated yogurt without QF, QF: concentrated yogurt with QF substituted at levels of 1%, 2%, 3%, and 4%.

Fig.1. preparation of quinoa flour

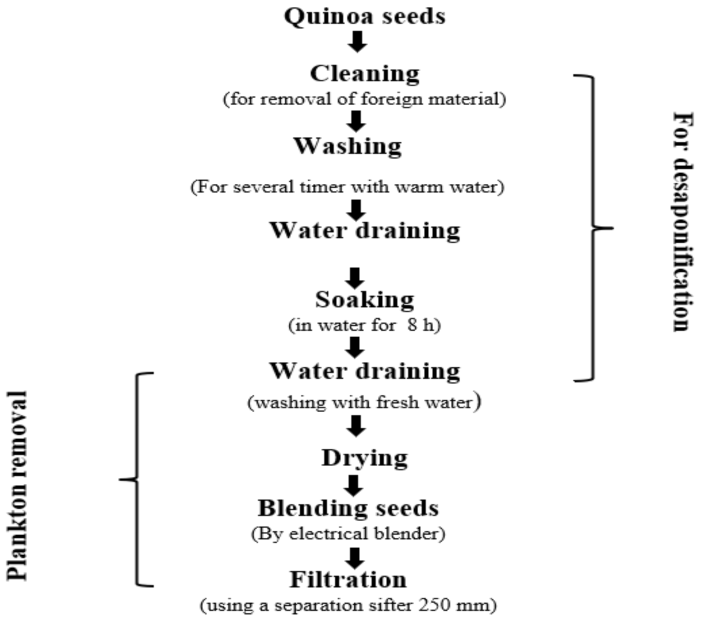


Figure1: preparation of quinoa flour

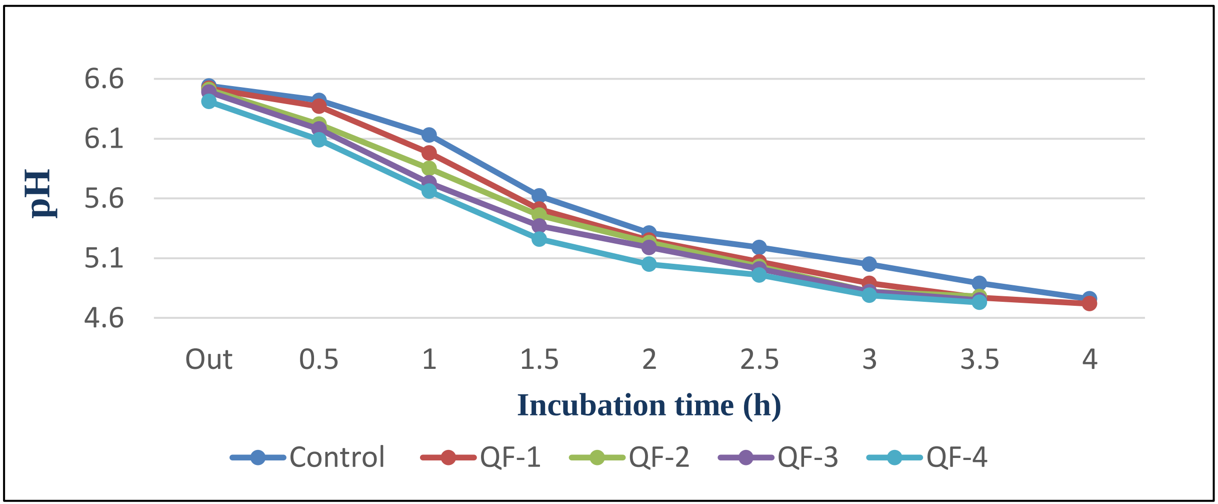


Figure 2: The pH values of concentrated Greek yogurt fortified by quinoa flour.
Control: concentrated yogurt without QF, QF: concentrated yogurt with QF substituted at levels of 1, 2, 3, and 4%, respectively.

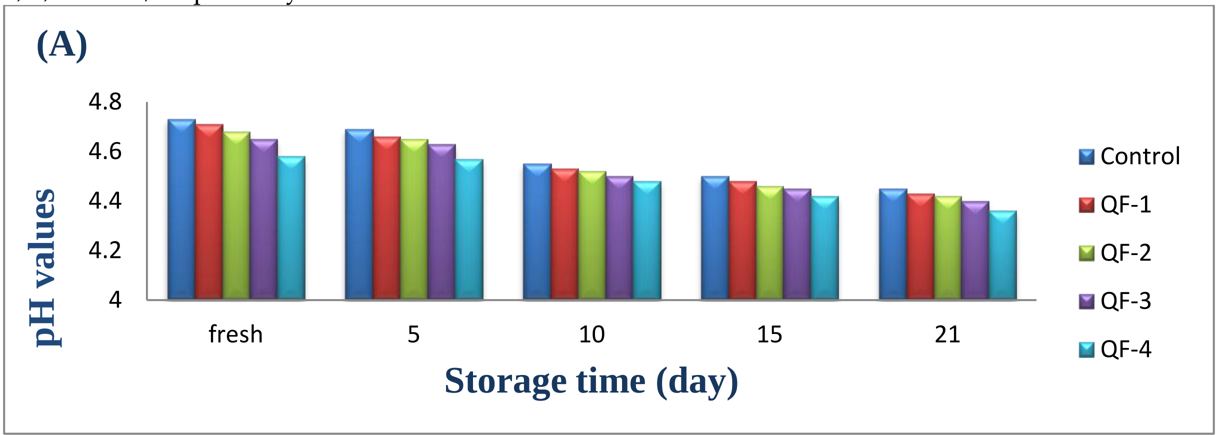


Figure 3: Effect of fortification of concentrated yogurt by QF on the changes in pH (A) and total titratable acidity (B) during storage.
Control: concentrated yogurt without QF, QF-1%, QF-2%, QF-3%, and QF-4%: concentrated yogurt with QF substituted at levels of 1%, 2%, 3%, and 4%, respectively.

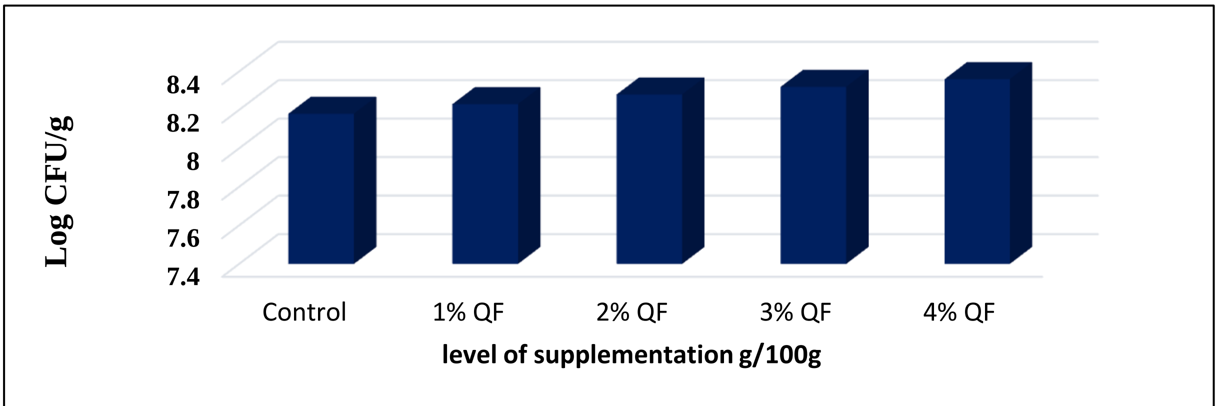


Figure 4: Viable lactic acid bacteria counts (Log CFU/g) of Greek yoghurt as impacted by supplementation with quinoa flour.

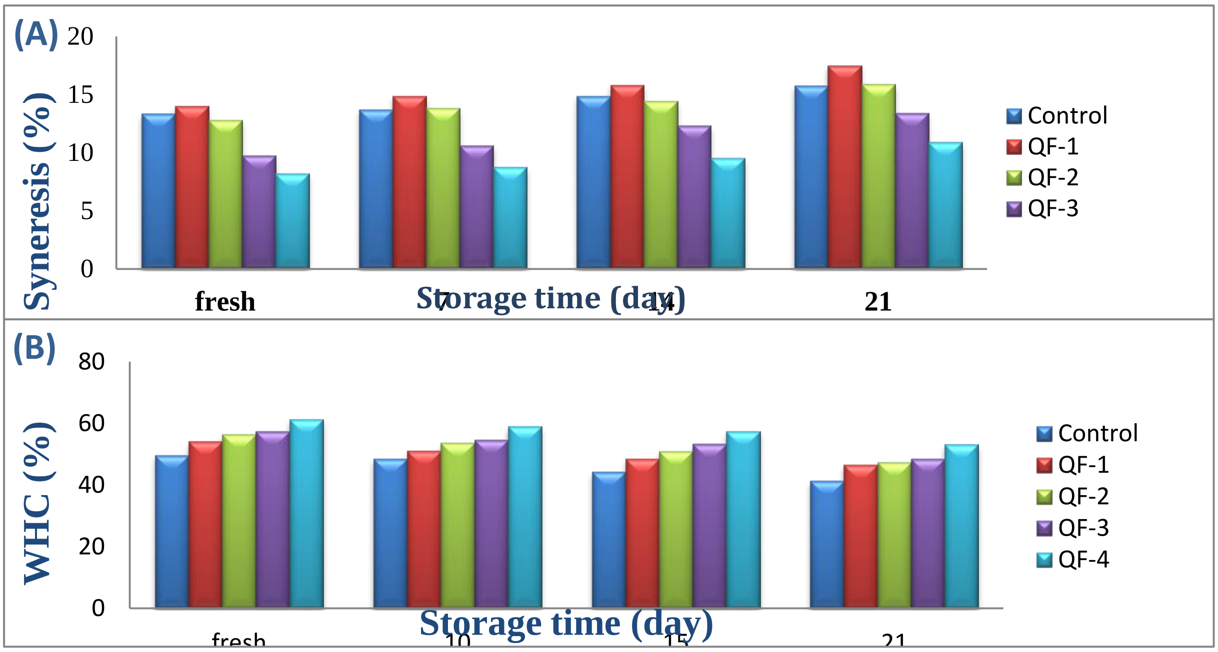
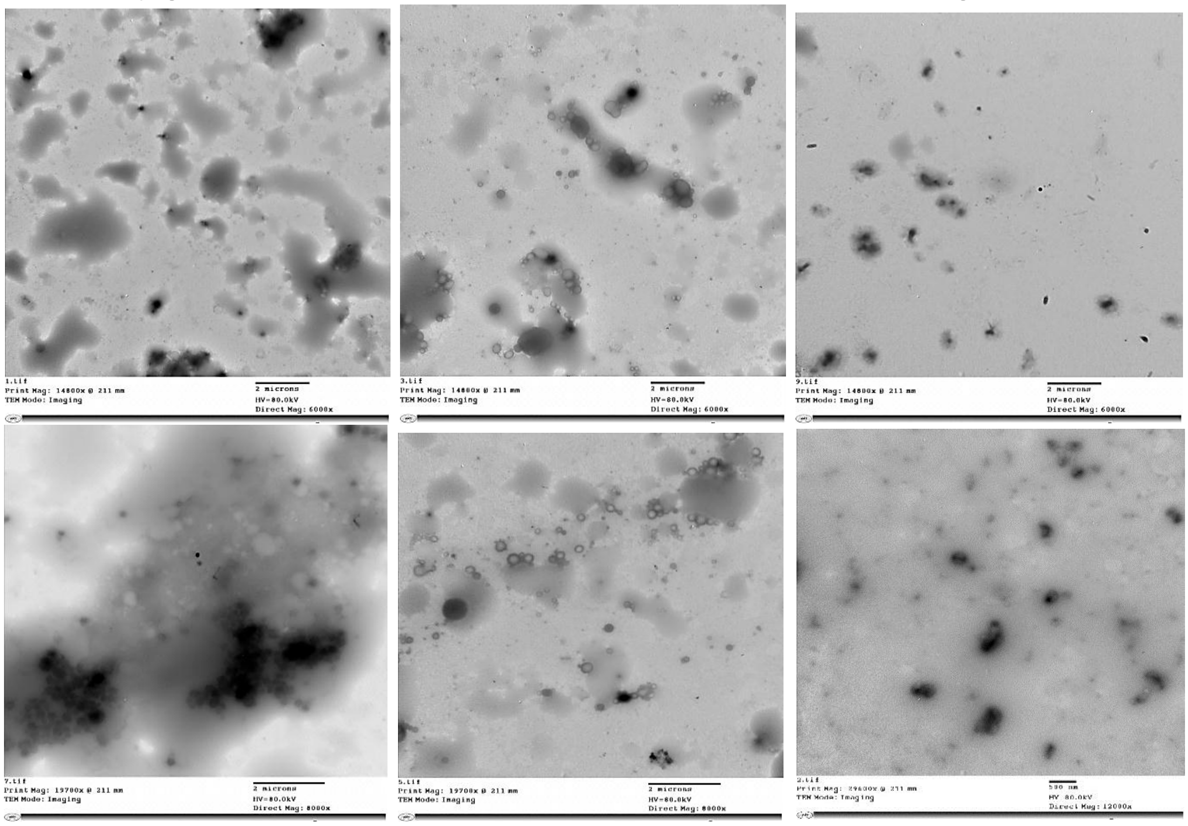


Figure 5: Effect of fortification of concentrated yogurt by QF on the changes in syneresis (A) and water holding capacity (B) during storage.
Control: concentrated yogurt without QF, QF-1%, QF-2%, QF-3%, and QF-4%: concentrated yogurt with QF substituted at levels of 1%, 2%, 3%, and 4% (w/w), respectively.

Greek yogurt 3% Qf **Control** **Negative Control.**



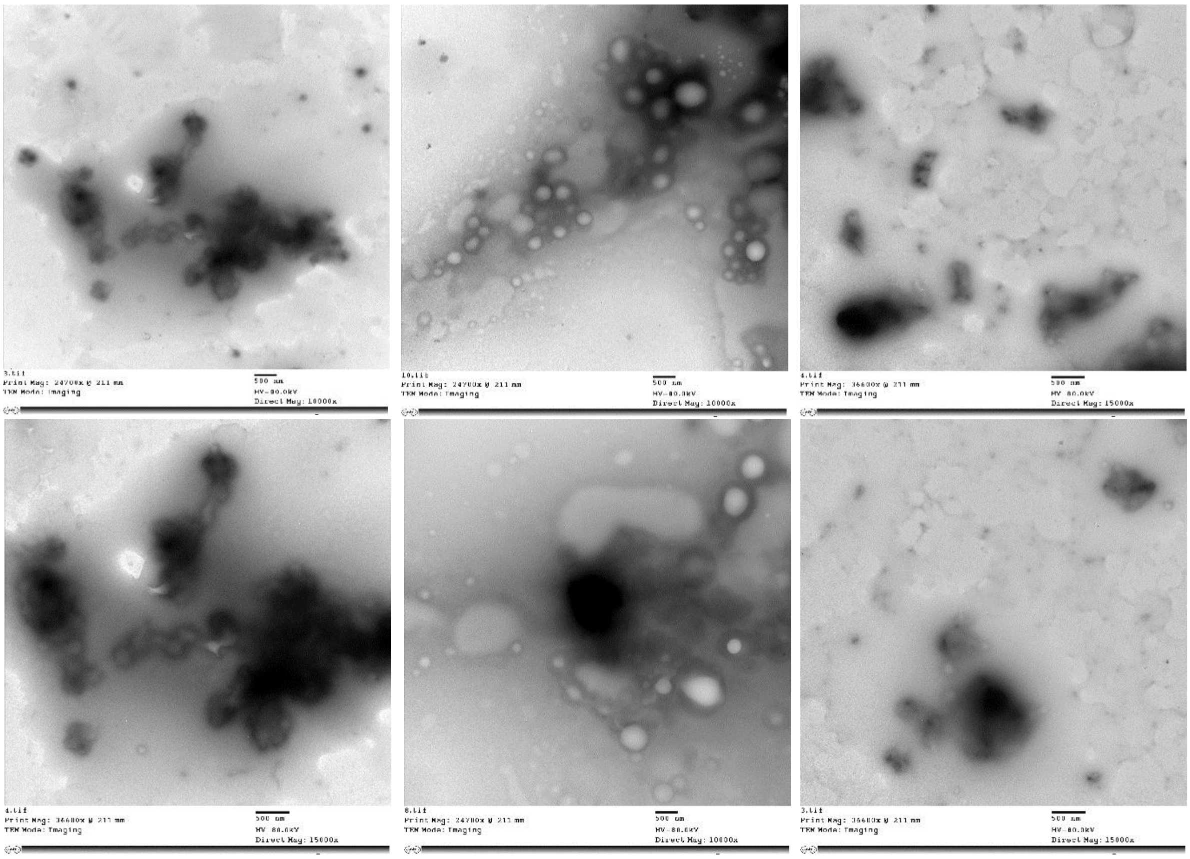


Figure 6: Transmission electron micrographs of Greek yogurts with and without flour.

Note: Samples: Negative Control = concentrated yogurt without quinoa flour and Starch stabilizer, Control = concentrated yogurt without QF, QF-3 = concentrated yogurt with QF 3%.

إنتاج الزبادي اليوناني الجديد باستخدام دقيق الكينوا

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الملخص العربي:

الزبادي اليوناني هو أحد منتجات الألبان المتخمرة المستحدثة حيث يتميز عن الزبادى العادى باحتوائه على نسبة جوامد صلبة كلية أعلى ونسبة أقل من اللاكتوز ، وبالتالى فإن خصائصه الحسية تختلف عن الزبادي العادي . ونظرًا لمتطلبات زيادة المواد الصلبة في الزبادي اليوناني فقد ركز هذا البحث على تدعيمه بمصدر نباتى عالى القيمة الغذائية وهو دقيق حبوب الكينوا لزيادة المواد الصلبة الكلية مع تحسين ثبات القوام وربط الماء دون الحاجة إلى مثبت صناعي. وتتميز الكينوا باحتوائها على العديد من العناصر الغذائية مثل الدهن والبروتين والكربوهيدات والنشا وبعض الأملاح المعدنية مثل البوتاسيوم والكالسيوم والمغنيسيوم والفوسفور والكبريت والحديد والزنك والأحماض الأمينية مثل أحماض اللينوليك (52٪) والأوليك بالإضافة إلى مميزاته الصحية حيث أثبتت الأبحاث ، أيضًا يشمل مركبات التوكوفيرول والكاروتينات مع مضادات الأكسدة العالية ، كما تحتوي بذور الكينوا على نسبة عالية من الفيتامينات مثل الريبوفلافين (فيتامين ب1، ب2، ب3، ب6). بالإضافة إلى ذلك ، فإن الكينوا غنية بالمركبات النشطة بيولوجيًا مثل الأحماض الفينولية والفلافونويد التي لها أنشطة مضادة للأكسدة . فى هذا البحث تم دراسة تأثير تدعيم الزبادي اليوناني بدقيق الكينوا بنسب (1، 2، 3، 4، 5 %) على بعض الخواص الحسية والكيميائية والريولوجية والتركيب البنائى . وفقًا لمعايير تصنيعية للزبادي اليوناني المكون من (لبن بقرى +قشدة بقري + لبن خالى الدسم مجفف + مركز بروتين مجفف + الإضافات من دقيق الكينوا) والذي تم تلقيحه ببادئ الزبادي اليوناني ، وتم تخميره وتبريده وتخزينه على درجة حرارة 4 ْم لمدة 21 يومًا. أظهرت النتائج أن إضافة دقيق الكينوا إلى الزبادي اليوناني عزز نمو البكتيريا وقلل من وقت التحضين. كما أظهرت النتائج أن الزبادي المدعم بنسب 1٪، 2٪، 3٪، 4٪ دقيق الكينوا أدى إلى تحسن كبير في لزوجة الزبادي أثناء التخزين. وأظهر التقييم الحسي وجود درجات قبول عام للزبادي اليوناني مع نسب إضافة من 1٪ إلى 4٪ من دقيق الكينوا بينما كانت نسبة الإضافة 5 % غير مقبولة . كما أشارت النتائج إلى أن زيادة الإضافة إلى مستوى 4٪ من الدقيق يمكن أن تكون خيارًا لتحسين مستوى إجمالي المواد الصلبة في الزبادي اليوناني دون وجود آثار سلبية على جودة المنتج والخصائص الحسية. وأشارت أيضا إلى أن إضافة دقيق الكينوا يحسن من خصائص التشريش والقدرة على الاحتفاظ وربط الماء لعينات الزبادي . كما أظهرت الصور المجهرية لعينات الزبادي اليونانى أن الشبكة البروتينية للعينات المدعمة بالكينوا تميزت بثبات أفضل من العينة المصنعة باستخدام المثبت الصناعي (الكنترول). لذلك يوصى هذا البحث باستخدام دقيق الكينوا بنسب إضافة تصل إلى 4 % لرفع محتوى الجوامد الصلبة الكلية وكمحسن لخصائص الزبادي اليونانى.

الكلمات الاسترشادية : الزبادى البونانى, دقيق الكينوا, التخمر والتركيب البنائى.