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The Effect of Using Different Kinds of Rice Containing Amylose on Yoghurt Quality

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ABSTRACT

Amylose is an essential source for plant energy. It has been broken down by α-amylose to maltotroise and maltose, which could be used as a source of energy. Amylose / amylopectin ratio is an important determinant of starch quality. It is also important as thickener, emulsion stabilizer, water binder and gelling agent. It is benefit for sugar levels and lowering cholesterol in blood. So, in this study, two varieties of rice, Giza 175 and Giza 178 which are characterized with their high and low amylose content, respectively, were examined, as they were added by 1:3% to yoghurt milk. In both fresh and stored yoghurt, the control samples had lower significant TS and TP contents than those recorded in the treated samples. Fresh yoghurt samples being treated with rice Giza 175 was of the highest values of CT. An increase of the amylose and Zn, as well as the improvement of reological properties as curd tension, synersis and viscosity of yoghurt were detected when Giza 175 was used. Treatments with high amylose content gained high scores in general appearance, firmness, smoothness and wheying off . High amylose verities of rice is useful for diabetics, so it could be used to increase the nutritional and health values of yoghurt.

INTRODUCTION

Granato *et al.* (2010) reported that all foods are functional at some physiological level, as they provide nutrients or other substances that furnish energy, sustain growth or maintain/repair vital processes. Functional foods move also beyond these necessities, providing additional health benefits that might reduce diseases risk and/or promote optimal health. Starch consists of two types of molecules. The linear and lelical amylose and the branched amylopectin. Starch generally contains 20 to 25% amylose by weight. Amylose is polysaccharide made of α-D-glucose units, bonded to each other through glucosidic bonds. Amylose is soluble in water more than amylopectin (Kaczkowshi, 2003, Brown, Poon and 2005 and Granfeldt *et al.*, 1994).).

The present study was mainly concerned with health benefits for the consumer of yoghurt containing of rice powder as healthy ingredients.

The texture of yoghurt is highly dependent on the amount and functionality of interacting components, as well as the technological treatment, increasing the level of protein, addition of stabilizers, homogenization and the Increase of the gel strength of yoghurt. The most used thickener and jellifying agent in food industries is starch. Starch have been modified through cross-linking, substitution, acid modification or all three. The use of starch products as stabilizer, is due to its ability to form gel when its dispersion in water is heated (Alexander, 1995 ; El-Garawany *et al.*, 2002 and Kebary *et al.*, 2004). Slow digestion and absorption of food carbohydrates (like high-amlyose varieties of rice), that facilitates blood glucose regulation. They might be counter productive to weight control. Rice starch has much higher amylose content than amylopectin (Jenkins *et al.*, 1988. and Brand-Milter *et al.*, 2002 Behall and Howe 1995 and Brand-Milter *et al.*, 2002). Glucose and insulin responses were significantly lower when a meal containing amylos, compared with amylopectin. No effect of amylose : amylopectin on postprandial triacylglycerol in blood or breath hydrogen (Granfeldt *et al.*, 1994 and Jenkins *et al.*, 1988, and Van Amelsvoort and Weststrate 1992)

Zinc - the main mineral in the used rice - has critical effect on homeostasis, immune function, oxidative stress, apoptosis, and on aging and significant disorders of great public health interest are associated with zinc deficiency. In many chronic disease, including atherosclerosis, several malignancies, neurological disorders, autoimmune disease, aging, age-related degenerative diseases, and Wilson's disease, the concurrent zinc deficiency may complicate the clinical features, affect adversely immunological status, increase oxidative stress and lead to the generation of inflammatory crytokines (Chasapis *et al.*, 2012).

The objective of this study was to evaluate the possibility of making a good quality and healthy yoghurt from cow's milk supplemented with rice starch.

MATERIALS AND METHODS

Fresh bulk cow's milk was obtained from herd of Sakha Animal Production Research Station, Animal Production Research Institute. Culture (YC-XII) of yoghurt starter which consists of *Streptococcus thermophilus* & *Lactobacillus delbrueckii* subsp. *bulgaricus* (Freeze-dried-Redy-Set) was obtained from Chr. Hansen Laboratories, Copenhagen, Denmark. Two rice varieties Giza 175 (26.0% amylose, 11% protein and 46 ppm zinc) and Giza 178 (18.56% amylose, 10.97% protein and 46.64 ppm zinc) were used. The grains were grinded and sifted before use.

For the preparation of yoghurt, fresh cow's milk (fat 4%, protein 3.45% and TS 12.18%) was divided into 7 portions: the first portion was used as control, while the second, third and fourth portions were treated with rice (Giza 175) with concentration of 1, 2, 3%, respectively. The fifth, sixth and seventh portions were treated with rice (Giza 178) with concentration of 1, 2, 3%, respectively. This was followed by heating at 90^{o}C for 10 min, and quickly cooled to 42±0.5^{o}C.

Milk from different treatments was inoculated with 2% activated yoghurt starter, transferred into 100 ml plastic cups, covered with lids, and incubated at 42±1^{o}C until the pH dropped to 4.8, then the yoghurt cups were cooled and transferred to the refrigerator (7±1^{o}C) (Tamime and Robinson, 1999).

Fresh and stored yoghurt samples were physiochemical analyzed for the titrtable acidity, pH values, fat, protein as described by Ling (1963), whereas ash content was measured according to AOAC

(2000). Zinc was determined by the atomic absorption according to the method mentioned by Sparks (1996).

Viscosity (pa. s) was measured in triplicates at 25°C using a digital thermometer. The readings were taken per samples at speed 2000 rpm, while spindle 5 was used for all measurements (Radomir *et al.*, 2009).

Curd tension (CT) was detected according to Chandrasekhara *et al.* (1957and Abd El-Salam *et al.*, 1991). Curd syneresis (CS) was determined using drainage method (Mehanna and Mehanna, 1989). The organoleptic properties of yoghurt were assessed according to El-Shibiny *et al.* (1979).

Determination of the amylose was carried out according to Krishnaswamy and Sreenivasan (1948).

Statistical analysis of variance and Duncan's test, as well as the average and standard error were carried out using a SPSS computer program (SPSS, 1999).

RESULTS AND DISCUSSION

The pH of fresh yoghurt was of 4.94 for the control and 4.92, 5.00, 4.85, 4.92, 4.99 and 4.89 for the treatments A1, A2, A3, B1, B2 and B3, respectively (Table 1).

Activity of yoghurt-stare culture (YSC) is of an important factor in yoghurt making, since low acidity of yoghurt unfavourably influences the consistency, due to insufficient protein hydration. Acidification to a pH of 4.6 and below tends to increase the hydration of protein. In general, quantity and type of protein in yoghurt milk should be taken into account in this respect. The slight differences in pH during fermentation of yoghurt milk, and subsequently in the resultant fresh yoghurt in the present study might be due to the type of rice, rather than the presence of more or less lactose. It is well known that only about 20-30% of lactose is consumed in the fermentation process (Mehanna and Hefnawy, 1990).

Data presented in Table (1) indicate that the addition of rice at 3% (A3 and B3) had a significant effect on the titratable acidity of fresh and stored yoghurt. Slight increase was recorded in the acidity, being 0.62, 0.65, 0.62 and 0.65% in A1, A2, B1 and B2, yoghurt treatment, respectively, compared with the fresh control (0.63%). Titratable acidity of yoghurt of different treatments increased after 15 days of storage. These results are in agreement with Kebary *et al.* 2004, Sakr (2004) and El-Nawasany (2012), which could be attributed to the slight activity of YSC on fermentation of lactose during the cold storage of the prepared yoghurt.

In both fresh and stored yoghurt, the control samples had lower significant TS and TP content (11.530 and 5.09%) than those recorded in the treated samples. These differences are due to the supplementation of yoghurt with rice that reflected on TS and TP content. This was evident with the increase in the added rice ratio. Data in Table (1) also showed that the highest TS was in A3 and B3 (13.66 and 13.61%) when fresh, and was 14.56 and 14.17% after 15 days of storage, whereas the TP content was 5.84 and 5.82% when fresh and 6.35 and 6.34% after 15 days of storage in A3 and B3, respectively. Such changes on storage were significant and could be due to the corresponding changes in TS content, Which came in agreement with Sakr (2004) and El-Nawasany (2012).

Table 1. Effect of rice starch (Giza 175 and Giza 178) on the pH, acidity, TS and TP of the fresh and stored yoghurt. (Average ± SE of 3 replicates)*.

	C	A1	A2	A3	B1	B2	B3
				Fresh			
pH	4.94±0.03^{a}	4.92±0.011^{a}	5.00±0.13f	4.85±0.04^{b}	4.92±0.12^{a}	4.99±0.01^{a}	4.89±0.05^{b}
acidity, %	0.63±0.09^{b}	0.62±0.01^{b}	0.65±0.08^{b}	0.72±0.08^{a}	0.62±0.03^{b}	0.65±0.09^{b}	0.73±0.14^{a}
TS, %	11.53±0.06^{d}	12.54±0.05^{bc}	12.85±0.04^{b}	13.66±0.31^{a}	12.32±0.14^{c}	12.75±0.10^{bc}	13.61±0.06^{a}
TP, %	5.09±0.025e	5.32±0.005^{d}	5.51±0.005^{b}	5.84±0.01f	5.32±0.01^{d}	5.46±0.003^{c}	5.82±0.01^{a}
				Stored (15 days)			
pH	4.82±0.01^{a}	4.78±0.02^{b}	4.80±0.12^{a}	4.73±0.14^{b}	4.85±0.03^{a}	4.83±0.08^{a}	4.77±0.11^{b}
acidity, %	0.75±0.09^{b}	0.76±0.01^{b}	0.78±0.01^{b}	0.82±0.04^{a}	0.73±0.03^{b}	0.78±0.05^{b}	0.81±0.01^{a}
TS, %	12.38±0.07^{d}	13.02±0.05^{c}	13.29±0.09^{c}	14.56±0.02^{a}	12.93±0.21^{c}	13.24±0.12^{c}	14.17±0.12^{b}
TP, %	5.62±0.01^{c}	5.91±0.01^{b}	6.05±0.05^{b}	6.35±0.03^{a}	5.90±0.005^{b}	5.92±0.01^{b}	6.34±0.12^{a}

*** C, control and A1, A2, A3 (1, 2, 3%) of rice starch Giza 175 and B1, B2, B3 (1, 2, 3%) of rice starch Giza 178, respectively.**
Averages (a, b, … etc) within the same row with different superscripts differed significantly (P<0.05).

Results in Table (2) show that the average content of ash were 0.95, 1.12 and 1.23% in fresh yoghurt made with rice 175 (A1, A2 and A3) and 1.02, 0.09 and 1.14% in the corresponding treatments being made with rice 178 (B1, B2 and B3), compared with 0.89% in the control. The corresponding values of ash after 15 days of storage were 1.01, 1.77, 1.28, 1.05, 1.23, 1.23 and 0.96. The changes – on storage – had nearly the same trend and could be due to the corresponding changes in TS content, which are in agreement with those given by Sakr (2004) and El-Nawasany (2012). Significant differences in Zn content in the examined yoghurt between control and treated samples were also detected. The Zn content of fresh yoghurt were 1.03 mg/100 g in the control sample, and 1.04, 1.09, 1.14, 1.04, 1.09 and 1.12 in treatments A1, A2, A3, B1, B2 and B3, respectively. The corresponding values were 1.05, 1.05, 1.09, 1.14, 1.05, 1.09 and 1.27 in the stored yoghurt (Table 2).

As shown in Table (2) the averages of amylose were 0.29, 0.60 and 0.82 in fresh yoghurt made with rice 175 (A1, A2 and A3) and in B1, B2 and B3 were 0.21, 0.42 and 0.62, respectively in fresh yoghurt made with rice 178, and the corresponding values of amylose were 0.32, 0.63, 0.85, and 0.24, 0.47, 0.62 after 15 days of storage.

Table 2. Effect of rice starch (Giza 175 and Giza 178) on the ash, Zn and amylose of fresh and stored yoghurt. (Average±SE of 3 replicates)*.

	C	A1	A2	A3	B1	B2	B3
				Fresh			
Ash	0.89±0.02^{e}	0.96±0.20^{de}	1.12±0.04^{abc}	1.23±0.01^{a}	1.02±0.01^{cd}	1.09±0.07^{bc}	1.14±0.02^{ab}
Zn	1.03±0.12^{d}	1.04±0.00^{c}	1.09±0.01^{b}	1.14±0.001^{a}	1.04±0.01^{c}	1.09±0.01^{b}	1.12±0.03^{a}
Amylose	-	0.29±0.02^{d}	0.60±0.01^{b}	0.82±0.06^{a}	0.21±0.06^{d}	0.42±0.01^{c}	0.62±0.03^{b}
				Stored (15 days)			
Ash	0.96±0.03^{b}	1.01±0.16^{b}	1.77±0.06^{a}	1.28±0.01^{a}	1.05±0.02^{b}	1.23±0.018^{a}	1.23±0.01^{a}
Zn	1.05±0.01^{c}	1.05±0.001^{c}	1.09±0.02^{b}	1.14±0.03^{a}	1.05±0.03^{c}	1.09±0.01^{b}	1.27±0.01^{a}
Amylose	-	0.32±0.01^{d}	0.63±0.06^{b}	0.85±0.01^{a}	0.24±0.01^{e}	0.47±0.03^{c}	0.62±0.01^{b}

*** See legend to Table (1) for details.**

Results in Table (3) show that CT of fresh yoghurt was completely different as affected by the supplementation of yoghurt with rice. Fresh yoghurt samples which treated with rice 175 were of the highest values of CT (26.0, 34.33 and 37.66 g, respectively), while samples which treated with rice 178 were of 24.67, 29.33 and 34.3 in order. On the other hand, the results increased as affected by storage period (15 days). Role of TS in this respect was given in details by Sakr (2004). who also gained the same trend of increase of CT due to storage. In case of fresh yoghurt treated with rice 175 (A1, A2 and A3) the synersis values after 10 min of synersis time were 3.32, 2.55, 1.38 g/15 g, respectively. The values of synersis after 60 min were 4.54, 4.31, 3.54 g/15g, respectively. In case of yoghurt treated with rice 178 (B1, B2 and B3) the synersis values after 10 min were 3.89, 2.68 and 1.87, respectively, and the corresponding values after 60 min. were 5.61, 4.74, 3.50 g/15g, respectively. This might be due to the high water binding capacity of starch (in fresh rice) which reduces free releasable water. The starch might also retrograde material that slightly decreases water binding capacity of molecules, but this phenomenon appears to be not important in comparison to the synersis of protein network. Table (3) shows that the viscosity increased in all treated samples, compared to the control. The results also indicated an increase of the viscosity in treatments with rice 175 and 178. The highest results were when rice 175 was used. The added (%) of the rice 175 resulted in decrease in the viscosity of the yoghurt. Starch is often added to milk base to enhance or maintain the appreciate yoghurt properties including texture, mouth-feel, appearance viscosity / consistency and to prevention of whey separation (wheying-off).

Table 3. Changes in rheological characteristics of fresh and stored yoghurt as affected by adding rice Giza 175 and Giza 178 in different formulation ratio. (Average±SE of 3 replicates)*.

	C	A1	A2	A3	B1	B2	B3
				Fresh			
CT	21.66±0.33^{f}	26.00±0.05^{d}	34.33±0.05h	37.66±0.02^{a}	24.67±0.03^{e}	29.33±0.02^{c}	34.33±0.01^{b}
CS (g/15 g)							
10 min	4.20±0.03^{a}	3.32±0.05^{b}	2.55±0.15^{c}	1.38±0.03^{e}	3.89±0.04^{a}	2.68±0.05^{c}	1.27±0.09^{d}
30 min	5.37±0.02^{a}	3.67±0.24^{bc}	3.46±0.02^{cd}	2.57±0.15^{e}	4.91±0.10^{a}	4.06±0.03^{b}	2.98±0.08^{ge}
60 min	5.90±0.02^{a}	4.55±0.21^{b}	4.31±0.41^{b}	3.55±0.24^{c}	5.61±0.11^{a}	4.74±0.09^{b}	3.50±0.10^{c}
viscosity	2735±0.11^{g}	3815±0.12^{e}	4105±0.21^{c}	4725±0.13^{a}	3445±0.14^{f}	3885±0.11^{d}	4315±0.17^{b}
				Stored for 15 days			
CT	25.33±0.33^{f}	30.33±0.33^{e}	40.11±0.57^{b}	44.66±0.12^{a}	27.67±0.31^{f}	32.67±0.31^{d}	36.33±0.11^{c}
CS (g/15 g)							
10 min	3.29±0.14^{a}	3.28±0.12^{c}	0.98±0.09^{e}	0.79±0.04^{f}	2.86±0.09^{b}	1.23±0.77^{d}	1.00±0.02^{e}
30 min	4.50±0.02^{a}	3.42±0.11^{c}	2.29±0.06^{e}	1.99±0.06^{f}	3.69±0.05^{b}	2.403±0.12^{e}	2.717±0.21^{d}
60 min	5.01±0.26^{a}	4.13±0.04^{b}	2.96±0.09^{d}	2.65±0.15^{e}	4.31±0.04^{b}	3.03±0.11^{d}	3.46±0.13^{c}
viscosity	4335±0.19^{f}	5315±0.11^{c}	5825±0.11^{b}	60.25±0.13^{a}	3075±0.21^{e}	315±0.15^{c}	5825±0.17^{b}

*** See legend to Table (1) for details.**

Amylose content in starch is likely to have an important bearing of the functional properties of starch Starch gels were considered as composites containing granules embedded in an amylose matrix, which increases in the rigidity of the granules. (Miles *et al.*, 1985 and Copeland *et al.*, 2009). Starch becomes soluble in water when heated. The granules smell and burst, the semi-crystalline structure is lost and the smaller amylose molecules start leaching out of the granule, forming network that holds water and increasing the mixture's viscosity. During cooking, the starch becomes a paste and increases further in viscosity.

As with the organoleptic properties of the examined treatments of yoghurt, Data in Table (4) indicated that treatments A3 and B3 gained highest scores in general appearance, firmness, smoothness and wheying off. However, treatments A2 and B2 were of the highest scores in flavour. The increase of Giza 175 and Giza 178 was probably the cause of the slight drop of score in the flavour. The scores given for some properties were relatively higher in treated yoghurt, compared with the control, which could be due to the using rice which gave more sweetness and more pleasant appearance and smoothness for the resultant product. On the other hand, some panelists disliked the slightly brown colour of the resultant yoghurt and also the weaker body as compared with the other treatments.

Table 4. Organolpetic properties of fresh and cold stored yoghurt as affected by rice Giza 175 and Giza 178 of different formulation ratio. (Average±SE of 15 replicates)*.

	C	A1	A2	A3	B1	B2	B3
			After 1 day				
General appearance (10)	7.1±0.18d	8.4±0.12c	8.9±0.15b	9.6±0.11a	8.4±0.11c	9.0±0.08ab	9.8±0.14a
Firmness (10)	7.1±0.13c	8.5±0.08b	9.0±0.08b	10.0±0.00a	8.4±0.09b	9.1±0.11b	10.0±0.00a
Smoothness (10)	7.2±0.14c	8.3±0.12b	9.1±0.12a	10.0±0.00a	8.3±0.06b	9.2±0.08a	10.0±0.00a
Wheying off (10)	6.8±0.12c	8.3±0.12b	9.2±0.08ab	10.0±0.00a	8.4±0.08b	9.3±0.11ab	10.0±0.00a
Flavour (60):							
Acid (10)	8.1±0.08c	9.0±0.04b	10.0±0.00a	9.2±0.17b	8.7±0.16b	10.0±0.00a	10.0±0.00a
Bitterness (10)	8.4±0.12b	8.4±0.06b	9.5±0.13a	9.1±0.11a	8.5±0.12b	9.6±0.11a	9.3±0.08a
flat (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a
Foreign (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	9.8±0.06b	10.0±0.00a	10.0±0.00a	9.7±0.19b
Cooked (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	9.7±0.11b	10.0±0.00a	10.0±0.00a	9.6±0.12b
Unclean (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a
			After 15 days				
General appearance (10)	7.3±0.11c	8.2±0.09b	9.2±0.14a	10.0±0.00a	8.3±0.13b	9.2±0.14a	10.0±0.00a
Firmness (10)	7.4±0.18c	8.6±0.11b	9.1±0.09a	10.0±0.00a	8.2±0.13b	9.3±0.07a	10.0±0.00a
Smoothness (10)	7.3±0.19c	8.6±0.01b	9.5±0.11a	10.0±0.00a	8.5±0.19b	9.3±0.07a	10.0±0.00a
Wheying off (10)	7.1±0.20c	8.6±0.18	9.0±0.16a	10.0±0.00a	8.0±0.11b	9.2±0.14a	10.0±0.00a
Flavour (60):							
Acid (10)	8.3±0.14b	9.2±0.11a	10.0±0.00a	9.3±0.12a	8.2±0.23b	9.2±0.08a	9.0±0.00a
Bitterness (10)	8.5±0.11b	8.6±0.09b	10.0±0.00a	8.7±0.11b	8.6±0.04b	9.6±0.15a	8.7±0.13b
flat (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a
Foreign (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	9.1±0.14b	10.0±0.00a	10.0±0.00a	8.8±0.19b
Cooked (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a
Unclean (10)	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a	10.0±0.00a

*** See legend to Table (1) for details.**

However, the differences in scores were almost insignificant due to the applied treatments. All samples were found free from the most important defects affecting quality of yoghurt such as settled, whey separation, fermented, unclean, formation of colonies or film on the surface, aged and not fresh taste. All the storage yoghurt samples were also free from cooked and unclean flavours. All samples were also free from the defects given in this respect for body and consistency and flavours by Rasic and Kurmann (1978) and Tamime and Robinson (1999).

It could be concluded that 2% Giza 175 rice are good sources of amylose and zinc in yoghurt manufacture. Giza 175 improved the product and provided the nutritional value and functional properties, so we can use it as an alternative to stabilizers.

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تأثير استخدام صنفين مختلفتين من الأرز المحتوي على الأميليوز لتحسين جودة الزبادى

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يعتبر الأميلوز مكون اساسى لتخزين طاقة النبات ، حيث يتحلل الاميلوز الى مالتورويز ومالتوز ، والذى يعتبر مصدر للطاقة ، تعتبر نسبة الأميلوز / الأميلوبكتين من العوامل الهامة التي تحدد جودة النشا. كما انه مهم للقوام وكمستحلب وكرابط للماء ومساعد لتكوين الجل. وذلك لتأثيره على مستويات السكر وخفض نسبة الكلوستيرول في الدم .ولذلك استخدم في هذه الدراسة صنفين من الأرز ، جيزة 175 العالى المحتوى من الاميلوز ، وصنف جيزة 178 المنخفض المحتوى من الأميلوز. تم إضافة صنفى الأرز بنسبة 1 : 3٪ إلى لبن الزبادى فى كل من الزبادى الطازج والمخزن انخفضت معنويا محتوى الجوامد الصلبة الكلية والبروتين فى عينات الكنترول عن العينات المعاملة . وقد سجلت النتائج زيادة في تركيز الأميلوز والزنك ، وكذلك تحسنت الخصائص الريولوجية للزبادى وكذا صلابة ، وطرد الشرش ولزوجة الخثرة عند استخدام صنف الارز جيزة 175. معاملة الزبادى بالارز عالى الاميلوز كان الاعلى فى درجات المظهر العام ، الملمس ، النعومة وطرد الشرش . استخدام الانواع عالية الأميلوز من الأرز مفيدة ايضا لمرضى السكر ويمكن استخدامها لزيادة القيم الغذائية والصحية للزبادي.