Effect of replacement of water by acid whey at different levels on quality characteristics of flat bread (balady) and fino bread

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ABSTRACT

This investigation was carried out to study the effect of replacement of water by different levels (25, 50, 75 and 100 %) of acid whey from Kariesh cheese for flat bread (balady) and 25, 50 and 75 % for fino bread on quality characteristics of the produced bread. Results indicated that whey replacement levels up to 50% to produce flat bread (Balady) having higher overall acceptability than control. As a result of using whey, minerals content of the resulted bread was increased and the rate of gas production was also increased. Similar results were also obtained with fino bread which was found to be not significantly different from control for the overall acceptability with replacing water by whey at levels up to 50%. However, the specific volume of the produced fino bread was lower than that of control, while the reverse was observed for the specific weight. Addition of whey leads also to improve the fermentation process.

***Key words**: Whey - Wheat flour- Balady and Fino bread.*

INTRODUTION

Whey has primarily been considered a waste by the dairy industry, and in late 20th century, regulations prevented disposal of untreated whey. At the same time, recognition of the value of whey components accelerated. Modern science has unravelled the secrets of whey proteins and other components, and established a sound basis for their nutritional and functional value **(Smithers, 2008).** In general, from 100 L of milk utilized during the cheese manufacture, approximately 80-90 L of whey is produced. Depending on the variety of the produced cheese (e.g. hard or semi-hard), the average yield is 1 kg from 10 L of milk, where the balance (9 L) is whey **(Guimarães *et al*., 2010)**

Whey is rich in proteins, water-soluble vitamins and lactose, whey is classified into two types, sweet whey with pH value of about 6.02 to 6.58 obtained from the manufacture of rennet-coagulated cheese and acid whey with pH value of 3.57 to 4.34 obtained during the production of acid-coagulated cheeses such as cottage cheese. Acid whey contains twice as much calcium as sweet whey **(Alsaed *et al*., 2013 and Mcmahon, 2013)**

Whey is widely used in the baking, confectionery, and pastry industries for production of breads, cakes, cookies, biscuits crackers, muffins, and icing **(Burrington, 1999 and Stoliar, 2009)**

Whey products are used by the baking industry because of their functional benefits. Some of these benefits recognized by consumers include good crust color developed through the Maillard browning reaction, good dairy flavor, softer crumb and extended shelf-life. Additional benefits that may recognize by the baker are the ability to reduce ingredients costs by partially or completely replacing egg products, milk powder or other ingredients such as shortening. Less commonly recognized are the

nutritional benefits of adding whey proteins to bakery products. Whey proteins have a high concentration of lysine, the deficient amino acid in wheat protein. Increasing the ratio of whey proteins to wheat protein results was an improved amino acid profile. Bread, soft rolls and buns are the major applications for using of whey **(Burrington, 1999).**

This investigation was carried out to study the possibility of using whey in production of both of balady and fino bread to enhance the quality of the produced bread and to increase its minerals content especially calcium.

MATERIALS & METHODS

Materials

Wheat flour 72 % and 82 % extraction were obtained from Mills South Cairo, unsalted acid whey from Kariesh cheese processing was obtained from Dairy Technology Dept. Faculty of Agriculture, Cairo University, other ingredients like sugar, salt, instant active dry yeast, shortening (vegetable oil) and bread improver were purchased from local market.

Experimental procedure

a- Fino bread Making:

Fino bread was prepared using the straight – dough method according to **Chauhan *et al*., (1992)** with some modifications, the baking formula were 500 g of flour (72% extraction) , 7.5 g of instant active dry yeast , 5 g of salt, 30 g of cane sugar, 25 g of vegetable oil, 5 gm of bread improver and approximately 280 ml of water. All the ingredients were mixed in a mixer for 6 min. The dough was fermented for 60 min at 28±1°C, then punched, divided into 60 g dough pieces, rounded, rolled, proofed for 60 min at 30±1°C and 85% relative humidity and then baked at 230°C, for 20 min. Same procedures were carried out with other treatments in which water was replaced by whey at levels of 25, 50 and 75%.

b- Flat bread (Balady) making:

The formula which used for production of balady bread consisted of: 1gm salt, 1.5 gm instant active dry yeast and 70 - 80 ml water (enough to make sticky dough) for each of 100 gm flour (82%extraction). The bread was produced according to the procedures described by **Hussein *et al*.,(2013)** as follows:

Flour, water, yeast and salt were mixed to optimum dough development (about 6 min.). The dough was placed in fermentation cabinet at 30°C and 85% relative humidity for 60 minutes, then divided into equal pieces and rested for 15 minutes and then dusted with flour and compressed by hand. The dough pieces were returned to the fermentation cabinet and proofed for 30 minutes, then baked at 400-500° C for 1-2 minutes. The loaves of bread were allowed to cool on racks for about 1 h before evaluation.

The same previous procedures were applied for other treatments in which water was replaced by whey at levels of 25, 50, 75 and 100%.

Analytical methods:

Proximate analysis*:*

The raw materials and the produced bread samples were analyzed for their contents of moisture, protein, fat, crude fibers and ash, according to the methods of A.O.A.C (2012). Carbohydrates were calculated by difference .

Whey was analyzed for moisture, protein, fat, ash, pH values and titratable acidity (TA %) according to the methods of A.O.A.C,(2012). Lactose was calculated by difference [total solids - (protein+ ash + fat)] according to the method of Pizzillo et al.,(2005) .

Determination of minerals:

Minerals contents were determined using atomic absorption spectrophotometer (model 3300, Perkin-Elmer, Beaconsfield, UK) according to the procedures outlined by A.O.A.C. (2012).

Determination of dough-raising capacity:

Cylinder test was used to determine the fermentation power of flat (balady) and fino bread according to the method described by Fernandes *et al*., (1985).

Sensory evaluation of flat bread (balady:

The bread was organoleptically evaluated for their sensory characteristics. i.e., crust color, crumb color, texture, flavor and eating quality and loaf rising according to **Faridi et al.,(1983)** using 10 experienced panelists from Faculty of Agriculture, Cairo University Giza, Egypt. The maximum scores were 10 for each of crust color, eating quality and loaf rising, 20 for texture, 25 for each of crumb color, flavor and 100 for overall acceptability. The average of total scores (overall acceptability) was converted to descriptive categories according to **El- Gepaly (1988)** as follows: very good grade from 90-100, good grade from 80 - 89, satisfactory grade from 70 - 79 and questionable grade less than 70.

Sensory evaluation of fino bread:

The produced bread samples were evaluated for their sensory characteristics, i.e., appearance, color of crust, color of crumb, crumb texture, odor and taste with scores of 20, 15 , 15 , 15 , 15 and 20, respectively using 10 experienced panelists from Faculty of Agriculture, Cairo University Giza, Egypt. The scoring schema was established as mentioned by **El - Gepaly (1988)**.

The average of total score (overall acceptability) was converted to descriptive categories as the following: very good grade from 90-100, good grade from 80-89, satisfactory grade from 70-79 and questionable less than 70.

Statistical analysis:

All data were analyzed using Co Stat, version 3.03 for personal computers according to

Ott, (1988) . The tests used were ANOVA test and descriptive statistics test. A treatment effect was assumed to be statistically significant at $P < 0.05$.

RESULTS & DISCUSSION

Chemical constituents of raw materials under study, i.e., wheat flour 72% extraction, wheat flour 82% extraction and whey were determined and the obtained results are shown in Table (1) From these results, it could be noticed that protein , fats , crude fibers, ash and total carbohydrates contents of wheat flour 72% extraction were 11.61% , 1.56% ,0.70% , 0.64% and 85.49% respectively, while wheat flour 82% extraction contained 13.36%, 2.10% , 1.82% 1.15% and 82.85% for the same components respectively. These results confirmed those of **Sharoba (2009) and Hussein *et al*. (2013).** The obtained results were found also to agree with those of **Afify *et al*., (2016).** They found that moisture ,protein ,fat ,crude fiber and ash contents were 11.89 % and 13.18 %, 10.55 % and 10.94% , 0.71% and 2.06 %, 0.47 % and 2.04% and 0.47% and 0.99 % for wheat flour 72 % and 82 % extraction, respectively.

The same results also indicated that whey contained 93% moisture, 0.2% fat, 0.61% protein, 0.82% ash, and 4.98% lactose. Total solids (T.S) and acidity values were 6.61% and 0.46%, respectively. However, pH value was 5.04. These results were found to be in agreement with those of **Divya and Rao (2010)**. **Hassan and El-Shazly (2013)** reported that whey contained 91.77% moisture, 8.23% T.S, 0.51% protein, 0.103% fat, 1.93% ash and pH value was 4.15.

Concerning minerals contents, the results presented in the same Table indicated that whey showed the highest contents of K and Ca comparing to both of wheat flours (72 and 82 % extraction). However, the chemical composition of cereal grains widely, depending on environment, soil and variety as

reported by **Shellenberger,(1978).** The minerals contents could be varied according to several factors such as the difference in planting location and planting time as reported by **Ezekwe et al., (1999). Smithers (2008)** reported that whey is an excellent source of bio-available calcium that improves bone health and calcium from the whey is readily absorbed in the intestine, facilitated by the presence of lactose. However the results of minerals content of both wheat flours (72and 82%ext) confirmed those obtained by **Sharoba et al.,(2009)** and those of whey were agreement with those reported by **Goyal and Gandh, (2009).**

The effect of replacement of water by whey at different levels, i.e., 25, 50, 75 and 100% for balady bread and 25, 50 and 75 % for fino bread on dough raising capacity of balady bread was studied and the obtained data were statically analyzed and the obtained results are illustrated in Figs.(1 and 2 ,respectively). The rates of increase in production of gas during fermentation were higher for all treatments of balady bread (Fig.1) containing whey than control sample. The maximum value at 120 min. was observed for treatment (3) followed by treatment (4). On the other hand, the same results showed also that after 60 min. the rate of gas production for all the treatments was higher than control and all values were significantly different form control with exception of treatment (1). These results confirmed those obtained by United States Dairy Export Council **(USDEC 2004)** reported that dough containing lactose show a tendency to rise faster during the initial stages of proofing and show improved stability and gas retention . **Wendoff and Emeritus (2008)** found that liquid whey may be used to replace water in some bakery products and this lead to better kneading of bread dough and to better yeast fermentation.

The results illustrated in

Fig.(2) showed that the retained gas by the dough (dough raising capacity) during fermentation process was higher for all the treatment samples than control and the retained gas values were increased as the levels of replacement by whey increased. All treatments samples were found to be significantly different from control for dough raising capacity at all fermentation periods. These results confirmed those obtained by **Dogaru *et al*., (2012).**They found that adding whey improves the dough workability and fermentation process. United States Dairy Export Council **(USDEC 2003)** also reported that in baking, lactose can contribute to improve gas retention**.**

Balady bread samples which produced using water that replaced by whey at levels of 25, 50, 75 and 100% were subjected to sensory evaluation for their crust color, crumb color, texture, flavor, eating quality, loaf rising and overall acceptability. The obtained data were statically analyzed and the obtained results are shown in Tables (2 and 3). From the results presented in Table (2) it could be noticed that bread samples of treatments (1) and (2) were found to be not significantly different from control sample for crust color, crumb color, eating quality and loaf rising. The same results of statistical analyses showed also that there were no significantly differences between control sample and treatment (3) which prepared using 75% whey for crust color, crumb color, texture, eating quality, loaf rising and overall acceptability. While, treatment (4) which prepared by 100% whey showed the lowest scores for crust color, texture, flavor and overall acceptability compared to the control. However, treatments (1) and (2) showed very good quality grade, since its scores were between 90 to100.

Moreover control and treatment 3 samples showed good quality grade (80 – 89). These results confirmed those of

Hassan and El-Shazly (2013). Their results suggested that fermented skim milk (FSM), acid cheese whey (ACW) can be replacing water with 25 and 50%, respectively in bread making to achieve better bread properties comparable to those of the control bread. In addition, the resulted bread was more nutritious, richer in flavor and taste compared to the control sample. However, the bread samples of treatments (1), (2) and (3) showed higher scores for overall acceptability than control sample and all showed very good quality grade. This might be due to the lactose content of the used whey which found to have variety of functional benefits as reported by **Burrington (1999)** who revealed that presence of lactose resulted in low relative sweetness, increased browning and enhanced flavors comparing to sucrose. Lactose readily reacts with proteins (Maillard reaction) giving baked goods highly flavored, desirable golden-brown color. Caramelization by heat during baking also contributes flavor and color. Lactose influences and enhances the controlled browning of bakery goods, leading to shorter baking times and lower temperatures to achieve even, stable, golden brown colors. This is a particular benefit in products targeted for microwave finishing.

Concerning fino bread samples which produced using water that replaced by whey at levels of 25, 50 and 75 %, the results presented in Table (3) indicated that fino bread samples of treatments (1) and (2) were found to be not significantly different from control for crumb color, crumb texture, taste and overall acceptability but it were significantly different from control sample for appearance. The same results showed also that there is no significantly different between treatment (2) and the control sample for crust color. The results presented in the same Table indicated that treatment (3) samples were found to be significantly

different from control for all the evaluated characteristics except crumb color. However, from these results, it could be revealed that whey could be used at replacement levels of 25 and 50% of water to produce fino bread having the same quality of control sample, since it showed very good quality grade (90 – 100) while, treatment (3) samples showed good quality grade (80 – 81) . These results are in agreement with **Dogaru *et al*.,(2012)**. They found that addition of whey to bread improves its nutritional qualities, acting not only on the contents, but also on the bread texture. Also, 30% whey addition has the best influence on the dough rheological features and leads to improve the elastic properties of the bread crumb.

The effect of replacement of water by whey at different levels, i.e., 25, 50, 75 and 100% on ash and minerals contents of flat bread (balady) and 25, 50 and 75 % for fino bread were studied and the obtained results were statically analyzed and are shown in Tables (4 and 5). It was observed that ash contents of balady bread samples were increased as levels of added whey increased and all treatments were significantly different from control sample. The results presented in the same Table showed also that replacement of water by whey lead to increase Ca, K and Mg contents of the bread samples at all the replacement levels and all treatments were found to be significantly different from control. These results confirmed those obtained by Stoliar (2009) who reported that using whey permeate source of calcium and other milk minerals.Also these results confirmed those of **Zommara et. al., (2007).** They studied the effect of whey on bread quality and they found that the bread contents of calcium (Ca),potassium (K) and magnesium (Mg) were affected by the level of whey incorporated to bread and there was a significant gradual increase in Ca and K with

increasing the level of whey in the produced bread.

Concerning fino bread samples, the results presented in Table (5) showed that replacement of water by whey resulted in an increase of ash, Ca, K and Mg contents of fino bread samples as replacement levels were increased. All treatments samples were significantly different from control for ash and the determined minerals with exception of treatment (1) which was found to be not significantly different from control for Mg content only. These increase could be related to the minerals content of whey comparing to those of water (traces). **Hassan and El-Shazly (2013)** found that the resulted bread could be considered more useful for people with renal and blood pressure problems. Significant proportion of the human population appears to be at risk due to a deficiency in one or more of micronutrients. Since bread is a major dietary source for the population. Fermented skim milk, acid cheese whey and buttermilk could be used as functional ingredients to improve the mineral and micronutrient contents. **Dogaru *et al.*, (2012)** found that whey addition to bread lead to increase magnesium, sodium and especially potassium contents. **Stoliar (2009)** reported that whey is source of calcium and other milk minerals. **USDEC (2003)** reported that Lactose increases calcium absorption and stimulates the growth of acid-forming lactobacilli in the intestinal track.

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Table (1): Chemical composition of raw materials:

Raw materials	Whey	Wheat flour 82%	Wheat flour 72%
Moisture %	93.39	13.36	11.09
Protein %	0.61	12.08	11.61
Fats %	0.2	2.1	1.56
Crude fibers %	-	1.82	0.7
Total carbohydrates %	-	82.85	85.49
Lactose%	4.98	-	-
T.S %	6.61	-	-
Ash %	0.82	1.15	0.64
Ca (mg/100g)	53.9	26	16.08
Mg (mg/100g)	22.05	295.53	91.08
K (mg/100g)	181	137.67	151.85

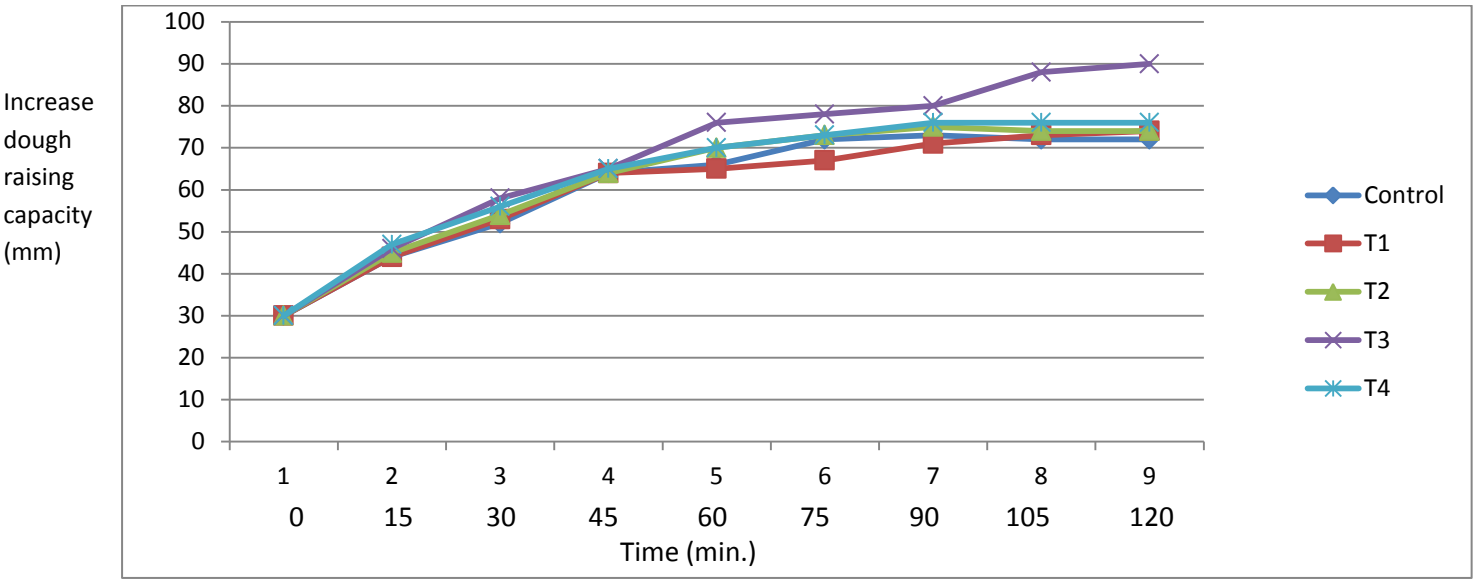

Fig.(1) Effect of replacement of water by different levels of whey (W) on dough raising capacity for flat bread (balady):

Control- Wheat flour (82% extraction) +100% water

T1- Wheat flour + (75% water+ 25% W) T2- Wheat flour + (50 % water+ 50% W)

T3- Wheat flour + (25% water+ 75% W) T4- Wheat flour + (0% water+ 100% W)

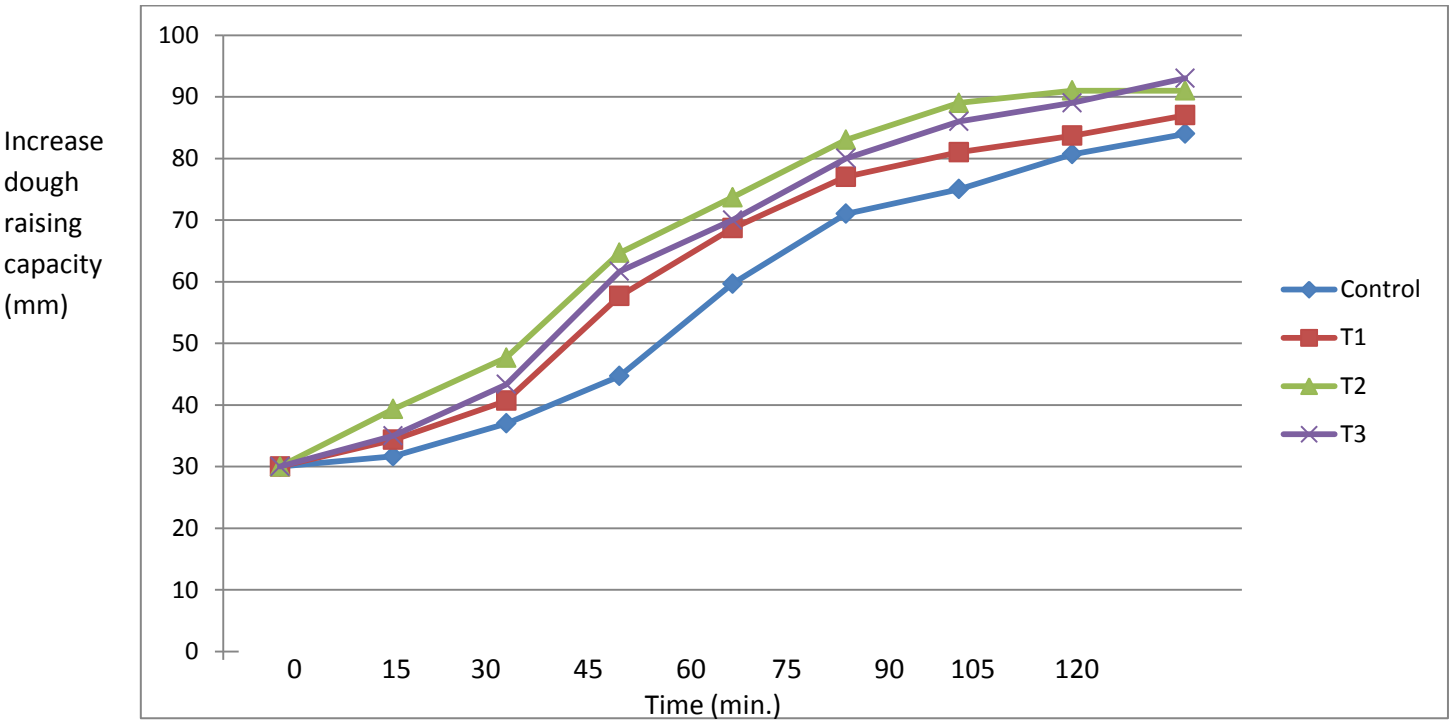

Fig. (2) Effect of replacement of water by different levels of whey (W) on dough raising capacity for fino bread:

Control- Wheat flour (72% extraction) +100% water

T1- Wheat flour + (75% water+ 25% W) T2-Wheat flour + (50 % water+ 50% W) T3-Wheat flour + (25% water+ 75% W)

Table (2): Sensory evaluation of balady bread prepared using whey (W) with water at different levels.

Sensory Characteristics							
Treatments	**Crust color**	**Crumb color**	**Crumb texture**	**Flavor**	**Eating quality**	**Loaf rising**	**Overall acceptability**
	10	**25**	**20**	**25**	**10**	**10**	**100**
control	8.66 ^{a} ± 0.57	21.00 ^{ab} ±1.73	17.00 ^{b} ±1.70	21.33 ^{b} ± 0,57	8.33 ^{ab} ± 0.57	8.33 ^{a} ± 1.15	84.66 ^{b} ± 1.53
T1	9.66 ^{a} ± 0.58	24.66 ^{a} ± 0.58	20.00 ^{a} ± 0.00	25.00^{a} ± 0.00	10.00^{a} ± 0.00	9.33 ^{a} ± 1.16	98.66 ^{a} ± 1.15
T2	8.66 ^{a} ± 0.57	23.33 ^{a} ± 1.15	19.33 ^{ab} ± 1.15	24.66 ^{a} ± 0.57	9.66 ^{a} ± 0.58	10.00 ^{a} ± 0.00	95.66 ^{a} ± 0.57
T3	8.33 ^{a} ± 1.15	22.33 ^{ab} ± 2.08	17.33 ^{b} ± 1.15	22.33 ^{b} ± 0.57	8.66 ^{ab} ± 0.57	9.66 ^{a} ± 0.57	88.66 ^{b} ± 4.16
T4	5.33 ^{b} ± 0.58	18.33 ^{b} ± 2.89	14.00 ^{c} ± 0.00	18.66 ^{c} ± 2.31	7.66 ^{b} ± 1.15	7.66 ^{a} ± 2.31	71.66 ^{c} ± 3.51
LSD	1.39	3.39	1.94	2.05	1.24	2.35	4.72

- *Values in the same column with different letters are significantly different (p≤ 0.05).*

Control- Wheat flour (82% extraction) +100% water

T1- Wheat flour + (75% water+ 25% W) T2- Wheat flour + (50 % water+ 50% W)

T3- Wheat flour + (25% water+ 75% W) T4-Wheat flour + (0% water+ 100% W**)**

Table (3): Sensory evaluation of fino bread made using water replaced b different levels of whey (W).

Sensory Characteristics							
Treatments	**appearance**	**crust color**	**crumb color**	**crumb texture**	**odor**	**taste**	**acceptability**
	20	**15**	**15**	**15**	**15**	**20**	**100**
Control	19.66 ^{a} ± 0.57	15.00 ^{a} ± 0.00	15.00 ^{a} ± 0.00	14.00 ^{a} ± 1.00	13.66 ^{b} ± 0.57	18.33 ^{ab} ± 0.57	95.66 ^{a} ± 2.51
T1	17.33 ^{b} ± 0.58	13.33 ^{b} ± 0.57	14.33 ^{a} ± 0.58	14.66 ^{a} ± 0.57	15.00 ^{a} ± 0.00	19.66 ^{a} ± 0.58	94.33 ^{a} ± 1.52
T2	18.33 ^{b} ± 0.57	14.33 ^{ab} ± 0.58	14.33 ^{a} ± 0.57	14.33 ^{a} ± 0.57	14.33 ^{ab} ± 0.57	19.33 ^{a} ± 0.58	95.00 ^{a} ± 2.64
T3	16.00 ^{c} ± 1.00	11.00 ^{c} ± 1.00	14.33 ^{a} ± 1.00	12.33 ^{b} ± 0.58	11.66 ^{c} ± 0.58	17.66 ^{b} ± 0.58	82.66 ^{b} ± 0.58
LSD	**1.33**	**1.22**	**1.22**	**1.33**	**0.94**	**1.09**	**3.77**

Values in the same column with different letters are significantly different (p≤ 0.05).

Con. Wheat flour (72% extraction) +100% water
T1-Wheat flour + (75% water+ 25% W) T2-Wheat flour + (50 % water+ 50% W)
T3-Wheat flour + (25% water+ 75%)

Table (4): Effect of replacement of water by different levels of whey (W) on ash and minerals contents of flat bread (balady) and fino bread:

		Minerals contents (mg/100gm)		
Treatments	**Ash%**	**Ca**	**Mg**	**K**
Control	1.93 ^{c} ± 0.01	56.34 ^{e} ± 2.05	33.55 ^{e} ± 2.13	236.68 ^{e} ± 3.34
T1	1.96 ^{c} ± 0.06	104.52 ^{d} ± 1.92	39.88 ^{d} ± 1.93	277.54 ^{d} ± 2.28
T2	2.02 ^{b} ± 0.02	112.82 ^{c} ± 1.89	44.38 ^{c} ± 1.58	293.44 ^{c} ± 2.94
T3	2.04 ^{b} ± 0.01	125.19 ^{b} ±4.08	52.61 ^{b} ± 2.72	300.28 ^{b} ± 4.88
T4	2.29 ^{a} ± 0.02	131.21 ^{a} ± 2.46	61.43 ^{a} ± 3.30	336.55 ^{a} ± 3.21
LSD .05	0.05	4.76	4.38	6.26

Values in the same column with different letters are significantly different (p≤ 0.05).

Con. Wheat flour (82% extraction) +100% water

T1-Wheat flour + (75% water+ 25% W) T2-Wheat flour + (50 % water+ 50% W)

T3-Wheat flour + (25% water+ 75% W) T4- Wheat flour + (0% water+ 100% W**)**

Table (5): Effect of replacement of water by different levels of whey (W) on ash and minerals contents of fino bread

		Minerals content(mg/100gm)		
Treatments	**Ash%**	**Ca**	**Mg**	**K**
Control	1.76 ^{c} ± 0.02	45.95 ^{d} ± 2.04	37.29 ^{c} ± 0.27	180.17 ^{d} ± 1.00
T1	1.95 ^{b} ± 0.03	89.57 ^{c} ± 1.65	37.59 ^{c} ± 0.26	203.56 ^{c} ± 1.05
T2	2.04 ^{a} ± 0.07	96.40 ^{b} ± 1.06	42.38 ^{b} ± 0.45	219.28 ^{b} ±0.22
T3	2.11 ^{a} ± 0.03	108.51 ^{a} ± 0.97	46.08 ^{a} ± 0.99	256.19 a ± 1.25
LCD	0.08	2.82	1.09	1.82

Values in the same column with different letters are significantly different (p≤ 0.05)

Control- Wheat flour (72% extraction) +100% water

T1-Wheat flour + (75% water+ 25% W) T2-Wheat flour + (50 % water+ 50% W)

T3-Wheat flour + (25% water+ 75% W)

تأثير استبدال الماء بالشرش الحامضى بنسب مختلفة على خصائص الجودة للخبز البلدى والفينو

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الملخص العربي

تم اجراء هذا البحث بهدف دراسة تأ ثير استبدال الماء بنسب مختلفة من الشرش الحامضي المتحصل عليه من صناعة الجبن القريش (25-50-75-100%) علي خصائص الجودة للخبز البلدي وكذلك تأثير استبدال الماءبنفس الشرش بمستويات (25-50-75%) بالنسبه علي خصائص جوده الخبز الفينو. أوضحت النتائج المتحصل عليها أن شرش الجبن يمكن استخدامه حتي مستويات ٥٠% لانتاج خبز بلدي ذو قابليه كليه أفضل من عينه المقارنه . ونتيجة لإستخدام الشرش زاد محتوي المعادن في الخبز الناتج وكذلك معدل إنتاج الغاز. وقد تم الحصول علي نتائج متشابهه مع الخبز الفينو حيث لم يوجد اختلاف معنوي عن عينه المقارنه في القابليه الكليه علي مستويات استبدال ٥٠% . إضافة شرش الجبن أدت أيضاً إلي تحسين عملية التخمر.

الكلمات الدالة : *الشرش – دقيق القمح – الخبز البلدي- الخبز الفينو.*