J. Food and Dairy Sci., Mansoura Univ., Vol. 8 (11): 449 - 453 , 2017

Utilization of Ras Cheese Sweet Whey, Acidic Cheese Whey and Permeate to Improve of Baladi Bread Properties

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ABSTRACT

Whey and permeate are the two principal by–products during industry of milk products. These by-products have a good nutritional value-approaching half of the value of the nutritional value of milk. However, it is completely wasted. In this study, that by-product has been used to prepare Egyptian baladi bread using wheat flour (82% extraction) and replace water dough with Ras cheese sweet whey (RCSW) or Acidic cheese whey (ACW) or Milk Permeate (MP). The results indicated that replacement water dough with RCSW, ACW or MP improved all Physico-Chemical and sensory characteristics of experimental baladi bread. Compared to control, MP achieved the best product followed by RCSW then ACW. Statistically, bread characteristics improved with increasing replacement ratio.

Keywords: baladi bread, whey, permeate, Physico-Chemical, sensory characteristics

INTRODUCTION

Bakery products especially bread in the developing countries which includes some Arab countries consider an important source of some food compounds such as, protein, minerals and vitamins. It is easy to support these products with cheap sources of protein, minerals and vitamins to counteract malnutrition in targeted population sectors (Indrani *et al.,* 2007). In Egypt, baladi bread is one of the most famous types of bread, which is made of wheat flour (82% extraction). This type is characterized by increasing of fiber, mineral and vitamins but lacks protein, fat and good appearance as well as it has limited shelf life that not exceed 48 hours.

Some additives have many benefits during baking industry such as increased extensibility, volume and improved crumb softness; these additives may be natural or chemical. The wastes of the dairy industry occupy the minds of many scientists, especially as they are rich in nutrient compounds and their neglect has a polluting role in the environment.

Whey and permeate are the two principal by–products during industry of milk products. These by-products have a good nutritional value-approaching half of the value of the nutritional value of milk. During cheese making, milk coagulation means deposition of proteins resulting in the separation of thin watery liquid called whey. Enzymatic coagulation of milk occurs using rennet enzyme at pH 5- 6 to induce coagulum but the acidic milk coagulum is happened when milk is acidified by lactobacillus culture or mineral acid. Whey permeate is a by-product, it separated when milk is passed through an ultrafiltration membrane to concentrate whey protein. Proteins and fats are retained by the membrane, they are called retentate. Whilst smaller particles such as salts and lactose pass through the membrane making up permeate. While retentate can be used in food products, the permeate has so far been of little value.

Biological oxygen demand for 5 days (BOD5) of the liquid waste from a big dairy, producing 50,000 L of whey/day, is twelve gm O_2/L, which create 300,000 g O_2/5days. Depending on European standards (OS), this is equivalent to the pollution output of 50,000 people. The profitable solution of that environmental problem is to merge and Insert waste whey into benefits industries such as food, chemical and pharmaceutical industries (Damodaran and Paraf 1997). There are many ways to rise the economic values of waste dairy industry (permeate), production of bioactive compounds is one of important method that can be used in the food industry (Goulas and Tzortzis 2007). Thus, the present study aims to utilize some dairy by-products {i.e. Ras cheese sweet whey (RCSW) or Acidic cheese whey (ACW) or Milk Permeate (MP)} in baladi bread making and to evaluate the effect of replacement of water with them on properties of baladi bread

MATERIALS AND METHOD

Local wheat flour (82% extraction) was obtained from Western mills, Tanta, Egypt. The fresh Ras cheese sweet whey (RCSW), Acidic cheese whey (ACW) or Milk Permeate (MP) were obtained from a private factory in Kafr- Al Sheikh (Hala). Instant active dry yeast and shortening was obtained from Gist-Brocades Co. Holland. Sugar and salt, were purchased from the local market.

Baladi bread making: Preparing of baladi bread was carried out depending on the method of Brown (1993) in one of the West Delta Bakeries. Baladi bread was prepared by mixing 1000 g of wheat flour (82% extraction) and 5 g of active dry yeast (*Saccharomyces cerevisiae*), Na Cl 1.5 g, about 80 mL of dough liquid as shown in Table 1 by hand for about 6 min to form the needed dough. To ferment the dough, it was left at 30°C and 85% relative humidity (RH) for an hour, divided into about 100 g chunks. To full fermentation, fine bran was spread on the pieces and left for 45 minutes at 30°C and 85% RH. Flattened pieces (diameter 20 cm) were proofed at 85% RH and 30 - 35°C for 15 min, baked at 400–500°C for 1–2 min. The fresh hot loaves were cold at room temperature for 2 hours, packed in polyethylene bags and stored at room temperature to routine analysis. Different wheat doughs were prepared as follows in Table (1).

Dough characteristics: Blends as shown in Table 1 were prepared by substituting dough water with Ras Cheese Sweat Whey (RCSW) or Acidic cheese whey (ACW) or Milk Permeate (MP). The effect of different dough liquid on dough rheology was estimated by

Farinograph depending on the standard methods (AACC, 2000). The elastic properties of dough were determined using Extensograph (Model Type No: 81010 Duisburg, 1979, Germany) according to (AACC, 2000).The protein of samples was estimated using Kjeldahl manner (AOAC, 2000).

Table 1. The ratio of water to RCSW or ACW or MP in dough solution

Treatments	Water	RCSW	ACW	MP
Control	100*	-	-	-
RB1	25	75	-	-
RB2	50	50	-	-
RB3	75	25	-	-
RB4	100	00	-	-
AB1	25	-	75	-
AB2	50	-	50	-
AB3	75	-	25	-
AB4	100	-	00	-
PB1	25	-	-	75
PB2	50	-	-	50
PB3	75	-	-	25
PB4	100	-	-	00

*** Wheat flour (82% extraction + optimum amount of water calculated from water absorption that was measured by farinograph). RCSW: Ras cheese sweet whey. ACW: Acidy cheese whey, MP: milk permeate**

Determination of color: Crust surface colour of baladi bread samples was measured. Parameters of colour (Hunter a*, b* and L*) were determined using a spectro-colourimeter (Tristimulus Colour Machine) with the CIE lab colour scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The instrument was standardized each time with white tile of Hunter Lab Colour Standard (LX No.16379): X= 72.26, Y= 81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16) (Sapers and Douglas, 1987). The Hue (H)*, Chroma (C)* and Browning Index (BI) were calculated depending on the method of (Palou *et al.,* 1999) as follows:

$H^* = \tan^{-1} [b^*/a^*]$ (1)

C*= square root of (a2* + b2*) (2)

BI = (100 (x-0.31)) 10.72 (3)

Where: $X = (a^* + 1.75L^*) / (5.645 L^* + a^* - 3.012b^*)$

Organoleptic attributes: The experimental loaves of bread were cold on shelves for about an hour before evaluation. According to El-Farra et al. (1982), the experimental Baladi bread loaves were sensory evaluated by 20- experienced arbitrators in baked goods and consumers

Statistical analysis: statistically, the results were analyzed by SPSS statistical package (Version 9.05) depending on Rattanathanalerk et al. (2005), variance analysis (ANOVA), Duncan's multiple range test and least significant difference (LSD) was chosen to estimate any significant difference amongst several treatments. Variations were found significant at $p<0.05$.

RESULTS AND DISCUSSION

Chemo-physical analysis of raw materials: Firstly, the quality of the food product mainly depends on the quality and chemical composition of materials involved in the manufacture, Physico-chemical composition of Wheat flour, Ras cheese sweet whey (RCSW), Acidic cheese whey (ACW) and milk permeate (MP) is given in Table 2. Data showed that RCSW had higher levels of TS and protein (9.37 and 0.62%), resp. followed by ACW then MP which had the lowest acidity (0.45%) followed by RCSW then ACW, pH took an opposite trend. On the other hand, ACW recorded the highest fat and ash % follow it RCSW then MP. Moreover, wheat flour (WF) contains 21.13, and 6.67 wet and dry gluten, resp. While gluten index and falling number were 71.48 and 321, resp. Regarding carbohydrates, WF contains 67.14 as starch while RCSW or ACW or MP contained 4.71, 4.10 and 4.82 determined as lactose. Wheat flour was rich in its protein and TS content (12.78 and 86.32 %, resp.) in addition to its moisture content (13.68%) and had 0.04 TA and pH 6. 71. These results were similar to those of Masur et al. (2009), Demir *et al.* (2009), Ammar *et al.* (2011) and Lonkar *et al.* (2011). Of course, these data will be reflected on the chemical and sensory characteristics of resulting balady bread.

Table 2. Physico-chemical analysis of baladi bread ingredients (% dry weight)

Item	Ingredients			
	Wheat flour	ACSW	ACW	PM
Moisture	13.68 ±0.05	90.63± 0.02	91.33± 0.025	94.21±0.05
Total solids(TS)	86.32± 0.025	9.37± 0.05	8.67± 0.0125	5.79± 0.065
Protein	5.78 ± 0.05	0.62± 0.025	0.57± 0.05	0.35± 0.05
Fat	1.32± 0.025	0.16 ± 0.015	0.26 ± 0.025	0.15± 0.015
Ash	0.52± 0.011	0.83± 0.018	0.91±0.015	0.79± 0.015
Wet gluten	21.13 ± 0.05	--	--	--
Dry gluten	6.67 ± 0.065	--	--	--
Gluten index	71.48± 0.12	--	--	--
Falling number	321± 0.00	--	--	--
pH- value	6.71± 0.02	5.75± 0.02	4.69± 0.02	5.91±0.02
TA	0.04±0.01	0.48±0.025	0.88±0.035	0.45±0.025
TC	67.14± 0.12	4.71±0.03	4.10±0.025	4.82±0.05

TC: Total carbohydrates, TA: Total acidity, RCSW: Ras cheese sweet whey, ACW: Acidy cheese whey, PM: milk permeate

Influence of replacement of dough water with various rations of WCSW or ACW or MP on dough mixing properties (Farinograph) of baladi bread dough made from wheat flour (82%). Data presented in Table 3 revealed the effect of replacing dough water with different percentages of WCSW or ACW or MP on Farinograph reading. In a comparative way of control dough (100% water) with RCSW or ACW or MP as a function of increment percent of protein in the dough, this function impact was more pronounced in experimental dough prepared by replacing water with different levels of MP, whereas the increase in water

absorption was up to 26% in the experimental dough sample with 100% PM. The non-prolamin proteins; albumins and globulins of wheat, comprises 15-20% of total wheat flour proteins. Albumins are soluble in water and globulins are soluble in salts (Singh and Skerritt, 2001). Regarding, gluten: The rubbery mass that is left when wheat flour is washed with water to remove starch, non-starchy polysaccharides, and water-soluble constituents, is called gluten. Gluten is comprised of 80–85% protein and 5% lipids; most of the remainder is starch and nonstarch carbohydrates (Wieser, 2007). On the other hand, all treatments (WCSW or ACW or MP) were higher than control in the Farinograph readings WA, AT, DDT, S, MTI and BU. The readings increased with increasing of RCSW or ACW or MP levels. This increase could be attributed to the water-soluble components of RCSW or ACW or MP such as lactose, albumins and globulins (Bilgin *et al.,* 2006). It has been well established that milk solids influence dough absorption. It is generally rule that dough absorption increases by a percentage equal to that of the dairy product used (Pyler, 1988). Erdogdu *et al.,* (1996) found that bread dough prepared with acid whey powder required 1% more water than did the control when heated at 80°C. Similar results were obtained by Hassan *et al.,* (2013

Table 3. Effect of replacement of dough water with WCSW or ACW or MP rations on Farinograph reading of baladi bread dough made from wheat flour (82%)

Treatments	WA (%)	AT (min)	DDT (min)	S (min)	MTI (BU)	(BU)
Control	56±0.20	2.5±0.10	6.5±0.12	10±0.10	40±0.11	80±2.30
RB1	59±0.20	2.5± 0. 15	6.5±0.12	11.5±0.12	40±0.11	85±2.50
RB2	62.2±0.3	3±0.21	7.5±0.12	13±0.11	45±0.12	85±2.50
RB3	64.1±0.3	3.5±0.18	8.5±0.15	12±0.08	45±0.10	90±3.10
RB4	65.5±0.2	3.5±0.15	9.5±0.15	12±0.12	55±0.08	95±3.50
AB1	58.5±0.20	2.5±0.12	6.5±0.14	11±0.10	40±0.08	80±4.10
AB2	61±0.30	2.5±0.11	6.5±0.12	10±0.05	40±0.10	85±.3.80
AB3	62.5±0.20	2.5±0.10	7.5±0.15	9±0.12	45±0.15	85±3.90
AB4	63±0.23	3±0.15	8±0.12	8.5±0.15	50±±0.12	90±3.10
PB1	58.8±0.25	2.5±0.15	7.0±0.18	11.5±0.12	40±0.13	85±2.80
PB2	62±0.20	3±0.15	7.5±0.15	13±0.05	45±0.05	85±2.50
PB3	63±0.25	3±0.18	8.0±0.12	12.5±0.12	50±0.12	90±2.50
PB4	64.2±0.29	3±0.10	9.5±0.12	12±0.13	60±0.08	95±.210

Where (WA) Water absorption (%), AT: Arrival time (min), DDT: Dough development time (min), S:Stability (min), MTI: Mix tolerance index (BU): weakening.

Influence of replacement dough water with RCSW, ACW and PM at varying levels on the elastic or extensible properties of the dough baladi bread (Extensograph) is illustrated in Table 4. Extensibility determines the ability of the dough to extend during gas production by yeast during proofing. Excessively high extensibility results in weak and slack dough, which collapses during the proofing stage or while baking in the oven. Maximum resistance to extension of the dough measures the ability of the dough to retain gas and subsequently to form springy bread. A very high resistance to extension also results in a lower loaf volume because the tough dough is not capable of proofing to an optimum height with the gas produced by the yeast (Sharadanant and Khan, 2003). There is a general approval about the link between testing and baking performance. A good loaf volume is achieved if the gas bubbles within the fermented dough expand with minimal rupturing during proofing and baking. Therefore, baking performance is related to the interplay between resistance to extension (Rmax) and extensibility (Anderssen *et al.,* 2004). Extensograph results for the investigated samples are summarized in Table 4. Compared with control, the decrement in maximum resistance to extension was ranged only 8.33% to 29.1%, 33.3, and 25% for RCSW or ACW or MP, resp.

These findings were in parallel with the findings of physical and sensory properties whereas replacement of water with 25 and 50, 75 and 100% RCSW or ACW or MP which had higher scores in sensory evaluation. The use of by- dairy products dairy ingredients improves the handling properties of bread dough, as well as the bread quality. However, the complexity of the bread-making, including deference stages of treatment and interaction among the ingredients, make it difficult to foretell the performance of a particular dairy product (Erdogdu-Arnoczky *et al.,* 1996).

Table 4. Effect of replacement of dough water with various rations of RCSW or ACW or MP on Extensograph properties of baladi bread dough made from wheat flour (82%)

Samples	Dough energy (cm3)	Dough extensibility (mm)	Dough resistance to extension (BU)	Proportion number (D=r/E)
Control	55	125	240	1.95
RB1	49	125	220	1.72
RB2	36	118	190	1.25
RB3	35	110	180	1.18
RB4	34	98	170	1.05
AB1	46	123	220	1.60
AB2	33	118	190	1.08
AB3	33	117	180	1.02
AB4	31	113	160	0.95
PB1	50	125	220	1.85
PB2	38	120	190	1.50
PB3	37	116	190	1.32
PB4	34	104	180	1.24

Colour properties: Colour properties is a major criterion that affects the quality of the final food product especially bakery products. The replacement of dough

water with different types of whey showed a variation in colour compared to the control sample (100% water). The improvement in colour was described as an intense colour, heat treatment of carbohydrates in whey and it was dependant on the replacement level. Mean colour values baladi bread of different treatments is recorded in Tables 5. In general, all colour parameters of experimental bread samples improved, the level of whiteness (L), redness (A), yellow (B), chroma (C*), hue angle (H*) and browning index (BI) enhanced in all supported samples. On the other hand, permeate improve all colour parameter of bread followed by Ras cheese sweet whey (RCSW), acidy cheese whey (ACW) then control. Furthermore, the color improvement of the baladi bread increased with the increase in the percentage of replacement, which confirms that the quality enhance with increasing replacement. The treatment of ACW was the lowest colour unlike the permeate which was the best. These results due to the reduction of lactose and increasing in ACW. Similar results were obtained by Hassan *et al.,* (2013) who substituted water with fermented skimmed milk, whey of acid cheese or buttermilk on dough Pan Bread.

Table 5. Effect of replacement of dough water with various rations of RCSW or ACW or MP on colour attributes of baladi bread

Treatments	L	a	b	C*	H*	BI
Control	55.50	6.82	20.25	21.33	19.50	97.26
RB1	56.30	7.25	20.39	21.50	19.89	105.22
RB2	59.21	8.20	20.98	22.78	20.21	108.60
RB3	61.18	8.98	21.14	23.30	20.55	112.5
RB4	65.08	9.65	21.52	24.18	21.10	111.15
AB1	55.92	7.12	20.11	20.51	19.44	97.88
AB2	57.61	7.95	20.37	21.75	20.10	110.12
AB3	59.00	8.37	20.80	22.22	20.22	99.52
AB4	61.25	9.00	21.05	22.87	20.84	114.21
PB1	57.22	7.14	20.44	21.95	20.10	98.55
PB2	60.13	8.31	21.10	23.38	20.79	105.68
PB3	64.10	9.11	21.45	24.11	21.13	112.31
PB4	67.18	9.96	22.15	25.97	21.55	109.85

L: Whiteness, A: Redness, B: Yellow, C*: Chroma, H*: hue angle and BI: Browning index

Table 6. Effect of replacement of dough water with various rations of WCSW or ACW or MP on protein, fat and ash contents of experimental baladi bread

Items	Treatments												
	control	RB1	RB2	RB3	RB4	AB1	AB2	AB3	AB4	PB1	PB2	PB3	PB4
P	5.68	5.81	5.89	6.04	6.18	5.81	5.90	6.03	6.15	5.77	5.84	5.93	6.00
F	1.33	1.37	1.41	1.45	1.48	1.39	1.45	1.50	1.55	1.36	1.39	1.43	1.46
A	0.51	0.70	0.9	1.10	1.30	0.73	0.94	1.15	1.37	0.70	0.89	1.07	1.26

P: protein %, F: fat%, A: ash%

Due to the importance of protein, fat and minerals, we had to determine these compounds in the resulting baladi bread. The results recorded in Table 6 show that replacement of dough water with various levels of RCSW or ACW or MP amended protein, fat and ash contents of experimental baladi bread. Protein, fat and ash statically increased in all mixtures and increment matched with the level of replacement. The highest increase was recorded when 100% of the dough water was replaced with RCSW or ACW or MP. MP was contained the lowest level of protein, fat and ash, while ACW was the highest level of fat and ash but RCSW recorded highest level of protein (6.18%). surely, these results affected by the chemical composition of materials of the dough mixes. These results coincided with that of Hassan et al. (2013) who replaced the water of dough with fermented skimmed milk, whey of acid cheese and buttermilk for preparing of Pan Bread.

Sensory characteristics of baladi bread: Panelists praised all experimental baladi bread (Table 7).

Table 7. Impact of replacement of dough water with RCSW or ACW or MP on Sensory evaluation of baladi bread (mean values)

Treatments	A	C&C	T	O	R	CD	SL	ULT	LLT
Control	6.68d	5.52^{c}	5.41^{d}	4.75^{d}	4.58^{d}	6.00c	4.92d	4.90^{a}	5.50^{a}
RB1	6.72^{c}	5.62^{b}	5.43^{c}	4.77^{c}	4.58^{d}	6.02^{b}	4.91^{d}	4.85^{a}	5.51^{b}
RB2	6.75^{b}	5.65^{a}	5.46^{b}	4.78^{c}	4.60^{c}	6.04^{a}	4.95^{b}	4.87^{a}	5.48^{c}
RB3	6.80^{b}	5.70^{a}	5.49^{b}	4.80^{c}	4.63^{c}	6.05^{a}	4.99^{a}	4.90^{a}	5.45^{c}
RB4	6.85^{a}	7.75^{a}	5.52^{a}	4.82^{b}	4.66^{c}	6.07^{a}	5.03^{a}	4.87^{b}	5.48^{c}
AB1	6.64^{d}	5.50^{c}	5.43^{c}	4.76^{c}	4.57^{b}	6.02^{b}	4.85^{c}	4.75^{c}	5.41^{d}
AB2	6.69^{d}	5.53^{c}	5.45^{b}	4.79^{b}	4.59^{b}	6.00^{b}	4.93^{b}	4.82^{b}	5.38^{d}
AB3	6.60^{d}	5.59^{b}	5.46^{b}	4.75^{c}	4.59^{b}	6.03^{b}	4.95^{b}	4.83^{b}	5.28^{d}
AB4	6.55^{e}	5.72^{a}	5.48^{b}	4.74^{c}	4.60^{b}	5.86^{d}	4.98^{b}	4.79^{b}	5.25^{d}
PB1	6.72^{c}	5.54^{c}	5.44^{b}	4.78^{c}	4.60^{b}	6.04^{a}	4.95^{b}	4.92^{a}	5.55^{b}
PB2	6.78^{b}	5.58^{c}	5.47^{b}	4.82^{b}	4.63a	6.09^{a}	5.00^{a}	4.90^{a}	5.59^{a}
PB3	6.88^{a}	5.63^{b}	5.51^{a}	4.86^{a}	4.67a	6.12^{a}	5.06^{a}	4.91^{a}	5.63^{a}
PB4	6.90^{a}	5.70^{a}	5.55^{a}	4.90^{a}	4.70a	6.15^{a}	5.11^{a}	4.89^{a}	5.68^{a}
LSD*	0.023	0.019	0.021	0.025	0.20	0.031	0.027	0.018	0.025

Where, A: Appearance, C&C: color & crust, T: taste, O, Odour, R: Roundness, CD: crumb distribution SL: separation layer, ULT: Upper Layer Thickness, LLT: Lower Layer Thickness. * Least Significant Difference.

Replacement of dough water with RCSW or ACW or MP improved sensory evaluation parameters of baladi bread included distribution of crumb, appearance, roundness, odor, separation layer, taste, upper, lower thickness and crust color compared to control sample. Sensually and statistically, it was noted that MP bread samples were the best followed by RCSW then ACW but the control got the lowest points. On the other hand,

the sensory characteristics of the experimental bread were improved with increasing of the percentage of the replacement of the dough water. These results may be back to acidity of acidic cheese whey, which contained low lactose and high acids, organic acids affected on elastic of wheat protein but decrease MP acidity and concentration of lactose and mineral salts improved the characteristics of baladi bread. Similar results for Pan Bread were obtained by Hassan et al. (2013). Furthermore, Al-Eid et al. (1999) found that the most effective in increasing the loaf volume happened at 50% substitution of milk permeate Compared to other treatments. Therefore, that could be due to lactose and lactic acid fermentation which may catalyze the gas formation during dough proofing.

CONCLUSION

It was concluded that replacement of dough water with Ras cheese sweet whey (RCSW) or Acidic cheese whey (ACW) or Milk Permeate (MP) improved the baladi bread quality. In general, trained panelists praised all experimental baladi bread but baladi bread prepared with MP got the highest quality followed by sample which prepared with RCSW then that prepared with ACW.

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الاسفادة من شرش الجبن الراس الحلو وشرش الجبن الحامضى والبيرميت فى تحسين صفات الخبز البلدى (المُدعم)

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خلال تصنيع اللبن ومنتجاته ينتج مشتقان ثانويان؛ هما الشرش الناتج من تصنيع الجبن والبيرميت الناتج من تركيز اللبن ؛ برغم انها تحتوى على اكثر من نصف قيمة اللبن الغذائية إلا انها تُهمل!، . في هذه الورقة البحثية ، تم استبدال ماء العجن بنسبة ٢٥ و ٥٠ و ٧٥ و١٠٠% من كل من الشرش الحلو الناتج من تصنيع الجبن الراس (RCSW)، و الشرش الحامضى الناتج من الجبن القريش (ACW) والبرميت الناتج من تركيز اللبن الحليب الطازج (MP) لإعداد الخبز البلدى المدعم باستخدام دقيق القمح (استخلاص ٨٢٪). أشارت النتائج إلى أن استبدال ماء العجن بـــ RCSW أو ACW أو MP بالنسب المشار إليها حسّن الصفات الفيزيائية - الكيميائية والحسية للخبز البلدى التجريبى مقارنةً مع عينات الكنترول المُصنعه بالماء، إحصائياً، حاز الخبز المُنع بالبيرميت على أعلى تقيم حسى لصفات الخبز التجريبى ثم RCSW واخيرا ACW، وزادالتحسن مع زيادة نسبة الاستبدال .