Production of high quality loaf breads with using whey products

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***Abstract*— The present investigation was carried out on preparation and utilization of fermented whey protein concentrate (FWPC) and whey permeate (WP) in bread to improve its quality. FWPC and WP were prepared from whey obtained during Feta cheese making and were separately incorporated in bread at 0 (control), 25, 50, 75 and 100% instead of water (v/v) throughout dough preparation. Increasing of WP up to 50% increased volume and height and specific volume of loaves and thereafter slightly decreased. However, all breads supplemented with WP had higher volume and height as compared to control. Contradictory to WP, increasing the level of FWPC, except at level 25%, progressively decreased loaf volume and height. Bread samples containing 75 and 100% FWPC had significantly lower loaf volume, height and specific volume than control and other supplemented sample. The highest loaf volume (622 cc), loaf height (9.2 cm) and specific volume (4.46 cc/g) were recorded for breads containing 50% WP. Independent of whey type (WP or FWPC) and incorporation levels, baking loss of bread decreased significantly with WP or FWPC fortification compared to the control, indicating higher moisture retained in supplemented breads. The highest baking loss was related to control as 19.02%, while the lowest monitored for supplemented breads with 100% FWPC as 15.83%.**

Keywords- Bread quality, loaf volume, baking loss, specific volume

I. INTRODUCTION

In last few years, whey and whey products are considered as appropriate ingredients for promoting nutritive value and organoleptic characteristics of many food products and as a substitute of milk and milk products because of their lower price. There are many possible products (whey protein concentrate, whey protein isolate, mineral powder, lactose etc.) and manufacturing processes (ultrafiltration, diafiltration, reverse osmosis, ion exchange, etc.) for utilization of whey constituents. However, these techniques are practically expensive and are possible and economical only when adapted on large scale. In many regions of Iran, cheese manufacturers cannot sell their whey due to high distance between them and whey powder factories. So they always dispose it which has created serious pollution problems. Furthermore, white brined cheese (Iranian Feta) is not only produced in large factories, but also produced by many small factories, dairy shops and even at home scale level. Since gathering of cheese whey in this way is not possible and sensible, application of a simple method for isolation and utilization of valuable whey proteins is thus necessary.

Fermented Whey Protein Concentrate (FWPC) is a semi-concentrated whey protein with more than 3.5% protein and acidity about 60-90 ^{o}D i.e. 0.6-0.9 per cent lactic acid [1]. The fresh FWPC has a white colour and lactic aroma which is achieved by a very cheap and simple way. This whey product can be used in the different varieties of food specially soy dairy products [2].

Foods of plant origin do not provide complete proteins that promote growth in human beings. The limiting amino acid in flour is lysine. The addition of lysine to a diet of wheat products provides a source of complete protein. Whey's lactalbumin has a high amount of lysine (11.8 %) [3]. Utilization of whey as incorporation of FWPC as well as permeate in bread will be a simple and economical way, which seems to be applicable method to improve bread quality.

II. MATERIALS AND METHODS

A. Preparation of FWPC

The fermented whey protein concentrate (FWPC) and permeate were prepared in the laboratory according to the method of Jooyandeh [4] by heating at 85ºC for 15 min and subsequent fermentation by yoghurt cultures at 42ºC for about 4 hrs.

B. Bread making

FWPC and whey permeate ingredients at the level of 0 (control), 25, 50, 75 and 100% were separately substituted instead of water (v/v) used for dough preparation in triplicate. Pasteurized whey permeate and FWPC were prepared before bread making and used freshly. All nine treatments (control, four treatments contain whey permeate and four treatments contain FWPC) of each replication were prepared in one day. Straight dough method [5] (10-10B) with procedure Irvine and McMullan [6] was followed for bread making. Bread loaves were analyzed for their physical characteristics including weight, baking loss, height, volume (by rapeseed displacement method) and loaf specific volume (cc/g) on the next day of bread making.

C. Measurement of bread specific volume and baking loss

Specific volume was performed based on substitution of rapeseeds by bread in a certain volume container and using following formula.

$$\text{Specific volume} = \frac{\text{Volume of bread}}{\text{Weight of bread}}$$

$$\text{Baking loss} = \frac{A - B}{A} \times 100$$

Where A is the weight of dough before baking and B is the weight of bread after baking

D. Statistical analysis

Two-way analysis of variance (ANOVA) was carried out using SPSS program (Version 20.0) to determine significant differences within the main factors and interactions. One-way analysis of variance also was carried out to determine significant differences between individual treatments. Duncan's multiple-comparison test was used as a guide for pair comparisons of the treatment means at $\alpha = 5\%$.

III. Results and Discussion

A. WP and FWPC composition

FWPC had higher protein, fat, total solids, acidity and lower carbohydrate than whey and whey filtrate. FWPC had also higher viscosity than whey and whey filtrate and its appearance resembled as stirred yoghurt/culture. The formation of protein aggregates due to denaturation of whey proteins during preparation of FWPC increases the volume occupied by the proteins and thus enhances viscosity [9].

B. Improvement of baking quality parameters

Statistically significant variations were observed in loaf volume, loaf height, specific volume and baking loss when breads were prepared with different level of supplementation and different type of whey (WP and FWPC) (Tables 1, 2).

TABLE 1
EFFECT OF DIFFERENT LEVELS OF WHEY PERMEATE (WP) AND FERMENTED WHEY PROTEIN CONCENTRATE (FWPC) ON BREAD MAKING QUALITY.

Treatments	*Level (%)*	*Loaf vol. (cc)*	*Loaf height (cm)*	*Specific vol. (cc/g)*	*Baking loss (%)*
Control	0	572 ±16^{a}	8.6 ±0.42^{a}	4.25 ±0.15^{ab}	19.02 ±1.09^{a}
	25	583 ±23^{a}	8.8 ±0.21^{a}	4.30 ±0.22^{ab}	18.44 ±0.65^{ab}
WP	50	622 ±35^{a}	9.2 ±0.40^{a}	4.46 ±0.27^{a}	16.91 ±1.04^{bcd}
	75	615 ±23^{a}	9.1 ±0.44^{a}	4.38 ±0.120^{ab}	17.13 ±1.49^{bcd}
	100	595 ±22^{a}	8.9 ±0.47^{a}	4.15 ±0.13^{ab}	16.38 ±0.91^{cd}
	25	583 ±43^{a}	8.7 ±0.62^{a}	4.22 ±0.31^{ab}	17.75 ±0.76^{abc}
FWPC	50	542 ±46^{ab}	8.5 ±0.60^{a}	3.85 ±0.35^{bc}	16.90 ±0.91^{bcd}
	75	492 ±79^{b}	7.7 ±0.55^{b}	3.40 ±0.55^{cd}	15.95 ±0.73^{cd}
	100	475 ±52^{b}	7.4 ±0.51^{b}	3.23 ±0.38^{d}	15.83 ±0.68^{d}

^{a,b,c} Means in the same column having different letters are significantly different ($P<0.05$).

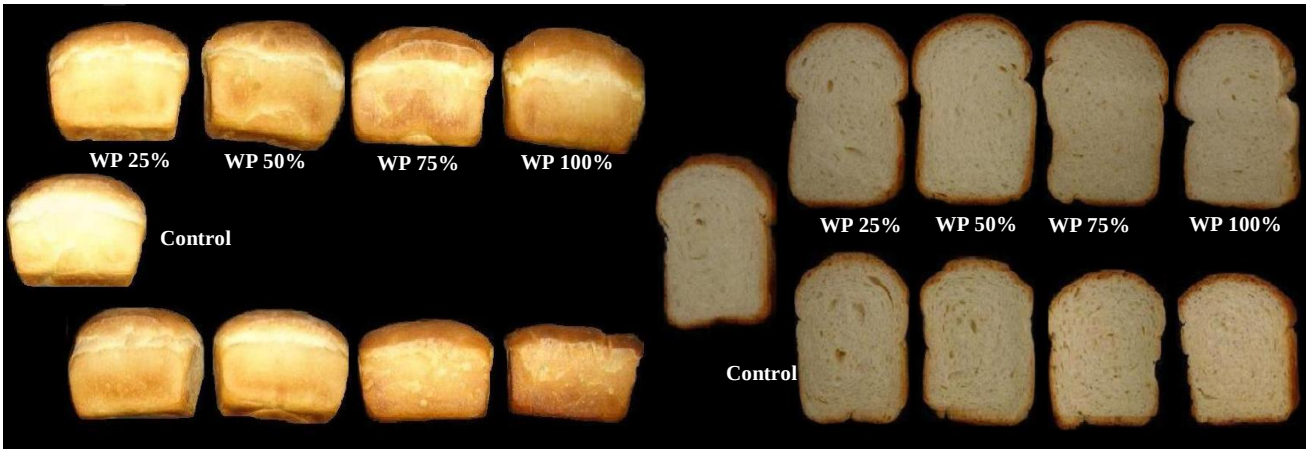

Fig. 1. Loaves of bread and cut portions of loaves supplemented with different levels of WP (above) and FWPC (below).

TABLE 2

THE VALUES OF SIGNIFICANT DIFFERENCES AND INTRACTIONS BETWEEN EXPERIMENTAL FACTORS LEVELS (TYPE AND CONCENTRATION OF WP AND FWPC) ON BREAD QUALITY PARAMETERS.

Sig. (≤0.05) between levels of:	*Volume*	*Loaf height*	*Specific vol.*	*Baking loss*
Type of whey (WP and FWPC):	0.000**	0.000**	0.000**	0.183
Concentration:	0.225	0.050*	0.012*	0.000**
Interactions:	0.026*	0.034*	0.023*	0.808

*Significant at 5%, **significant at 1%.

Increasing WP up to 50% increased volume and height of loaves and thereafter slightly decreased. However, all breads supplemented with WP had higher volume and height as compare to control (Fig. 1). Contradictory to WP, increasing the level of FWPC, except at level 25%, progressively decreased loaf volume and height. Bread sample containing

75 and 100% FWPC had significantly lower values than control and other supplemented sample, while the differences between other samples were not significant (Table 1, 2). The highest loaf volume (622 cc) and loaf height (9.2 cm) were recorded for breads containing 50% WP, while the lowest (475 cc and 7.4 cm) were recorded for bread samples containing 100% FWPC.

Increase in loaf volume and height of bread by supplementation of whey and whey proteins have been comprehensively reported [7]-[10]. In agreement with our results, Brar [7] found that addition of whey up to 15% (substitution base on total solids of flour) increases loaf volume; thereafter (incorporation up to 20%) slightly reduces. The decrease in loaf volume in bread fortified at higher levels of FWPC could be expected from the dilution of wheat gluten by nonglutenous proteins in FWPC [10].

The impact of different levels of WP and FWPC on specific volume of bread is shown in Table 1. As compare to control, supplementation with WP up to level 50% enhanced specific volume and thereafter slightly decreased. However, differences between supplemented breads with WP and control were not significant. The specific volume of control and supplemented breads with WP at levels 25, 50, 75 and 100% were 4.25, 4.30, 4.46, 4.38 and 4.15% cc/g, respectively.

Supplementation with FWPC had adverse effect on specific volume of loaf breads and incorporation of increasing amount of FWPC into the control, led to progressive decrease in specific volume. This indicated that incorporation of FWPC in bread gives a compact texture to bread (Fig. 1). The specific volume of supplemented breads with FWPC for levels 25, 50, 75 and 100% were 4.22, 3.85, 3.40 and 3.23 cc/g, respectively. The results relating to effect of FWPC on specific volume of bread are in agreement with those reported by Gelinas and Lachance [11] who observed that incorporation of fermented milk-whey ingredients significantly reduces specific volume of bread by 20%.

Independent of whey type (WP or FWPC) and incorporation levels, baking loss of bread decreased significantly with WP or FWPC fortification compared to the control, indicating higher moisture retained in supplemented breads. The highest baking loss was related to control with 19.02%, while the lowest monitored for supplemented breads with 100% FWPC with 15.83%. It can be observed from Table 1 that baking loss in both supplemented breads with WP and FWPC was not significantly different. However, breads supplemented with FWPC had lower baking loss than other supplemented breads because of higher whey proteins.

References

[1] H. Jooyandeh, and K. S. Minhas, "Effect of addition of fermented whey protein concentrate on cheese yield and fat and protein recoveries of Feta cheese," *J. Food Sci. Technolo.*, vol. 46, no. 3, pp. 221-224, 2009.

[2] H. Jooyandeh, "Soy Products as Healthy and Functional Foods," *Middle-East J. Scientific Res.*, vol. 7, no. 1, pp. 71-80, 2011.

[3] M. F. Haupt, D. M. McKee, G. Mayers, and L. K. Pollina, "Fortification of Cornbread with Lysine," *J. American Dietetic Assoc.*, vol. 97, no. 9, pp. A83-88, 1997.

[4] H. Jooyandeh, "Effect of addition of fermented whey protein concentrate on texture of Iranian white cheese," *J. Texture Studies*., vol. 40, pp. 497-510, 2009.

[5] Anonymous. *Cereal Laboratory Methods*. American Association of Cereal Chemists (AACC), Inc. St. Paul, Minn., USA, 1990.

[6] G. N. Irvine, and M. E. MacMullan, "The remix baking test," *Cereal Chemistry*, vol. 37, pp. 603-613, 1960.

[7] R. S. Brar, "Utilization of by-products of milk and soymilk in value added baked products," *Ph.D. dissertation*, Punjab Agricultural University, Ludhiana, India 2000.

[8] N. Erdogdu-Arnoczky, Z. Czuchajowska, and Y. Pomeranz, "Functionality of whey and casein in fermentation and in breadmaking by fixed and optimized procedures," *Cereal Chem.*, vol. 73, no. 3, pp. 309-316, 1996.

[9] H. M. Jayaprakasha, and H. Brueckner, "Whey protein concentrate: A potential functional ingredient for food industry," *J. Food Sci. Technol.*, vol. 36, no. 3, pp. 189-204, 1999.

[10] C. Kadharmestan, B. K. Baik, and Z. Czuchajowska, "Whey protein concentrate treated with heat or high hydrostatic pressure in wheat-based products," *Cereal Chem.*, vol 75, no. 5, pp. 762-766, 1998.

[11] P. Gelinas, and B. Lachance, "Development of fermented dairy ingredients as flavor enhancers for bread," *Cereal Chem.*, Vol. 72, no.1, pp. 17-21, 1995.