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EFFECT OF PARTIAL SUBSTITUTION OF MILK SOLIDS WITH WHEY PROTEIN CONCENTRATE POWDER IN "LABNEH" MADE BY ULTRAFILTRATION

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ABSTRACT

The aim of this study was to investigate the compositional, rheological and organoleptical characteristics of Labneh made by ultrafiltration as affected by partial substitution of milk solids with whey protein concentrate powder (WPCP). Labneh based on ٢٦٪ total solids (TS) and ٠,٥٪ NaCl was made from buffaloes' milk retentate concentrated by ultrafiltration. The milk solids in the retentate was partially substituted with WPCP at the levels of ٠, ١٠, ٢٠, ٣٠ and ٤٠٪. The results indicated that the fat and lactose contents as well as pH values of Labneh decreased with increasing the ratio of WPCP. However, the protein content, ash, titratable acidity (%)increased with increasing the added amount of WPCP. The Labneh consistency coefficient and the yield stress were obviously increased as the level of WPCP increased. During cold storage of Labneh, its acidity and diacetyle contents increased up to ٢١ days, while acetaldehyde content increased up to ٧ days of cold storage then decreased thereafter. Organoleptically, the Labneh quality was improved by adding WPCP with all of the examined levels, and remained acceptable during cold storage up to ٢١ days. Thus, milk solids in UF buffaloe's milk retentate could be substituted by WPCP at level of ٣٠٪ in Labneh made with acceptable quality at lower cost.

Keywords: Labneh manufacture, Buffaloe's milk retentate, Whey protein concentrate powder, Milk solids not fat substitution

INTRODUCTION

Consumers nowadays are increasingly interested in their personal health, and expect that foods they eat to be-beyond attractiveness are also safe and healthy. As interest in the link between diet and health gathers pace, many consumers seek ways to feel and stay healthy by eating nutritionally designed foods (Pimiae *et al.* ٢٠٠٣).

The traditional manufacture of Labneh is labour intensive and unhygienic. Besides the losses of product due to its adherence to the cloth bags are quite higher, therefore, during over the past three decades, several techniques of Labneh manufacture have been developed. In one of them, Labneh is produced from yoghurt by centrifugation (Dagher and Ali, ١٩٨٥ and El-Kenany, ١٩٩٥). Alternatively, Labneh may be made by concentrating a mixture of yoghurt and brine (Kharrazi, ١٩٨٤) using centrifugal separator. In another method, warm skim milk-yoghurt is concentrated to desired level of solids using a nozzle of quarg separator and cream is later blended with the product (Salji *et al.* ١٩٨٣; Tamime & Robinson, ١٩٨٣ and Rasic, ١٩٨٧). Labneh can also be made from ultrafiltration process (Abd-El-Salam & El-Alamy, ١٩٨٢; El-Samragy & Zall, ١٩٨٨; Tamime *et al.* ١٩٨٩ and Ozer *et al.* ١٩٩٨). Furthermore, other modifications were declared in the Labneh production such as direct supplementation of milk solid with dried milk,

whether to the final level (Gilles, ١٩٧٨ and Gilles & Lawrence, ١٩٨١) or partially (Hamad & Al-Sheikh, ١٩٨٩ and Amer *et al.* ١٩٩٧).

With that in view, the objective of the present research was to manufacture Labneh from buffaloes' milk retentate with partial substitution of milk solids with whey protein concentrate powder (WPCP) which might lower the cost of its production.

MATERIALS AND METHODS

Buffaloes' milk retentate was obtained from the UF plant of Agricultural Research Center, Giza, Egypt. Whey protein concentrate powder was obtained from SFK DATABZIAD, Hvidovce & Viborg, Denmark. The gross composition of these materials is presented in Table (١). Salt produced by El-Nasr Salines Company was obtained from the local market. Freez-dried yoghurt culture which consists of *Streptococcus savlvarious* sub. *thermophilus* TCC-٣ and *Lactobacillus delbruecki* subsp. *bulgaricus* were purchased from Chr. Hansen's Laboratories, Denmark.

The milk retentate (control batch) was heat treated to ٨٥°C/٥ min., then cooled to ٤٢°C. Fermentation of UF-retentate was done according to Tamime and Robinson (١٩٨٣). Total solids of buffaloes'milk retentate (٢٦٪) was substituted with WPCP at ratios of ١٠, ٢٠, ٣٠ and ٤٠٪, respectively. The mixtures were heat treated to ٨٥°C/ ٥ min., cooled to ٤٢°C and fermented as mentioned before. The cold fermented Labneh treatments were salted at the rate of ٠,٥٪ NaCl. Three replicates were done.

Titratable acidity, moisture, total protein, fat, lactose and ash contents of Labneh were determined according to the methods described by A.O.A.C. (٢٠٠٠). pH values of Labneh samples were recorded by using digital pH meter model SA٧٢٠ (Orion, USA).

Acetaldehyde and Diacetyl contents were determined according to Lees and Jago (١٩٦٩). Rheological properties were measured at ١٠°C using a rotary viscometer (RHEOTEST, type RV Medingen, Dresden) as described by Toledo (١٩٨٠).

Dynamic viscosity and consistency coefficient were calculated from the descending flow curve using the following equation: Log σ = Log K + Log y:

Where: σ= shearing stress, y = shearing gradient or shear rate
and κ = consistency coefficient

The yield stress was calculated by the equation of (Bourne, ١٩٨٢)

$$\sqrt{\delta} = \sqrt{\delta 0} = \eta a \sqrt{y}$$

δ = shear stress δ ٠ = yield stress
η_a = apparent viscosity and y = shear rate

Labneh treatments were organoleptically assessed by a panel of the staff persons from dairy department, Food Technology Institute, Agriculture Research Center according to Pappas *et al.* (١٩٩٦).

RESULTS AND DISCUSSION

As seen from Tables (١ and ٢) the gross composition of Labneh made from milk retentate by partial substitution of milk solids with WPCP decreased in T.S., fat and lactose contents, while increased in those those of protein and ash. This might be due to the higher contents of protein and ash increased by increasing of supplementation ratios of WPCP. These results are in agreement with those of Abd El-Salam & El-Alamy (١٩٨٢) and Hofi (١٩٨٨ and ١٩٩٠).

Table ١. Average gross composition of dairy materials used

Properties	Buffaloes' milk	Ultrafiltration retentate	Whey protein concentrate powder
T.S %	١٦	٢٦,١٢	٤٤,٨٠
Protein %	٤,٠	٩,١١	٨٠,٨٣
Fat %	٧,٠	١٠.٩٣	٨,٥٠
Lactose %	٤,٢	٤,٢٠	٢,٥٠
Ash %	٠,٨٠	١,٨٨	٣,٠٠

Table ٢. Gross composition of Labneh made from milk retentate by partial substitution of milk solids with WPCP

Properties	Level of WPCP substation				
	Control	١٠%	٢٠%	٣٠%	٤٠%
T.S %	٢٥,٦٢	٢٥,٧٩	٢٥,٦١	٢٥,٤٣	٢٥,٢٥
Protein %	٩,١١	٩,٥٦	٩,٦٣	٩,٦٩	٩,٧٦
Fat %	١٠,٩٣	١٠,٢١	٨.٠٢	٧,٨٣	٦,٦٤
Lactose %	٤,٢	٤,٠٣	٣,٨٦	٣,٦٩	٣,٥٢
Ash %	١,٨٨	١,٩٩٢	٢,١٠٤	٢,٢١٦	٢,٣٢٨

WPCP= Whey protein concentrate powder

Regarding the rheological properties of Labneh made from milk retentate by partial substitution of milk solids with WPCP, the obtained data (Table ٣) indicate that there were an increase in all the rheological parameters measured, i.e. consistency, yield stress and apparent viscosity with the increase of the supplementation ratio. These results are in agreement with those reported by Ozer *et al.* (١٩٩٨) and Jensen & Nielsen (١٩٨٢).

Table ٣. Rheological properties of Labneh made from milk retentate by partial substitution of milk solids with WPCP

Properties	Level of WPCP substation				
	Control	١٠%	٢٠%	٣٠%	٤٠%
Consistency coefficient (dyne. Sec./cm^{٢})	٢٢٦,٥٦٩	٢٩٨,٦٥٠	٣٥٨,٧٢٠	٣٩٠,١٤٧	٤١٥,٣١٤
Yield stress (dyne/cm^{٢})	١٤٨,٥١٢	١٦٨,٥٨٠	١٧٥,٥٨٠	١٩٧,٦١٤	٢٤٨,٣١٢
Apparent viscosity (poise)	٥٣,١٢	٥٥,٢٨	٥٦,٩١	٥٧,٨٢	٥٨,٧٥

WPCP= Whey protein concentrate powder

Titratable acidity and pH values were determined in all Labneh treatments when fresh and during cold storage. The results in Table (٤) show that the Labneh acidity increased as the level of WPCP increased. Also, the acidity was further increased by cold storage up to ٢١ days. The trend of the changes in pH values of all treatments was opposite to that of acidity which may led to protein ratio increase and lactic acid production as s result of microorganisms metabolism (Abd-Allah *et al.* ١٩٩٣)

Table ٤. Titratable acidity (TA%) and pH values of Labneh made from milk retentate by partial substitution of milk solids with WPCP during cold storage.

Cold storage period (days)	Level of WPCP substitution									
	Control		١٠%		٢٠%		٣٠%		٤٠%	
	TA	pH	TA	pH	TA	pH	TA	pH	TA	pH
Fresh	١,٦٨	٤,٣٩	١,٨٤	٤,٢٣	١,٩٢	٣,٩٨	٢,١٣	٣.٨٧	٢,٣١	٣,٧
٧	١,٩٤	٤,٢٧	١,٩٦	٣,٩٤	٢,١٣	٣,٨٣	٢,٣٤	٣,٧٥	٢,٥٢	٣,٦٩
١٤	٢,٢٥	٣,٩٨	٢,٤٢	٣,٨٥	٢,٣١	٣,٧٨	٢,٥٢	٣,٦٩	٢,٦٣	٣,٦٢
٢١	٢,٣٤	٣,٨٦	٢,٥٤	٣,٧٨	٢,٦٥	٣,٦٩	٢,٧١	٣,٦٠	٢,٧٨	٣,٥٦

WPCP= Whey protein concentrate powder

Table (٥) demonstrates the acetaldehyde (AC) and diacetyl (DA) contents in Labneh made from milk retentate by partial substitution of milk solids with WPCP. The results reveal that both of AC and DA contents of Labneh gradually increased as the ratio of WPCP increased. The levels raised further until the ٧th day of cold storage for AC and until the ١٤th day for DA. Thenafter, the levels of both compounds reduced until the end of the cold storage period. These results are in agreement with the results obtained by Hassanein *et al.* (٢٠٠٨).

Acetladehyde can be converted into to ethanol by alcohol dehydrogenase (Tamime and Robinsonm ١٩٨٣). This may explain the lower amount of acetaldehyde observed during the cold storage period.

Table ٥. Acetaldehyde (AC) and diacetyl (DA) (µmol/١٠٠ g) of Labneh made from milk retentate by partial substitution of milk solids with WPCP during cold storage

Cold storage period (day)	Level of WPCP substitution									
	Control		١٠%		٢٠%		٣٠%		٤٠%	
	AC	DA	AC	DA	AC	DA	AC	DA	AC	DA
Fresh	١٨٣,٥	١٠٠,١	١٨٥,٥	١٠٠,٣	١٨٩,٢	١٠٠,٩	١٩٢,٥	١٠٣,٥	١٩٨,٥	١٠٦,٢
٧	٣٥٢,٥	١٣٠,٨	٣٥٩,٢	١٣٢,٣	٣٦٢,١	١٣٥,٦	٣٦٧,٢	١٣٩,٥	٣٨٠,٠	١٤٢,١
١٤	٣٠٠,٩	١٤٩,٥	٣٠٥,١	١٥٠,٩	٣٠٩,٥	١٥٢.٦	٣١٠,٥	١٥٨,٢	٣٢٠,٣	١٦٠,٥
٢١	١٦٣,٨	١٥٠,٤	١٦٩,٣	١٦٦,١	١٧٢,١	١٦٨,٧	١٧٥,٣	١٧٢,٤	١٧٩,٢	١٧٩,٦

WPCP= Whey protein concentrate powder

Panel scores are listed in Table (٦) which indicate that the appearance, consistency and flavour of Labneh made from milk retentate by partial substitution of milk solids with WPCP. There was no effect on

organoleptic quality at cold storage till ١٤th day at the level of ١٠٪ of WPCP substitution. All other treatments gained lower scores with cold storage after the ٧th days.

Generally, the total score that reflecting the overall sensory quality of Labneh indicated that all samples remained acceptable until the end of the ٧th day. Our results are in agreement with Mahfouz *et al.* (١٩٩٢).

Table ٦. Organoleptic scoring of Labneh made from milk retentate by partial substitution of milk solids with WPCP during cold storage

Level of WPCP	Cold storage period (days)	Organoleptic attributes			
		Appearance (٥ points)	Consistency (٥ points)	Flavour (٥ points)	Total (١٥ points)
Control	Fresh	٥	٥	٥	١٥
	٧	٥	٥	٥	١٥
	١٤	٥	٥	٥	١٥
	٢١	٤,٥	٤,٥	٤,٥	١٣,٥
١٠٪	Fresh	٥	٥	٥	١٥
	٧	٥	٥	٥	١٥
	١٤	٥	٥	٥	١٥
	٢١	٤,٥	٤,٠	٤,٥	١٤,٠
٢٠٪	Fresh	٥	٥	٥	١٥
	٧	٥	٥	٥	١٥
	١٤	٤,٥	٤,٥	٤,٥	١٣,٥
	٢١	٤,٥	٤,٥	٤,٥	١٣,٥
٣٠٪	Fresh	٥	٥	٥	١٥
	٧	٥	٥	٥	١٥
	١٤	٤,٥	٤,٥	٤,٥	١٣,٥
	٢١	٤,٥	٤,٥	٤,٥	١٣,٥
٤٠٪	Fresh	٥	٥	٥	١٥
	٧	٥	٥	٥	١٥
	١٤	٤,٥	٤,٥	٤,٥	١٣,٥
	٢١	٤,٠	٤,٠	٤,٠	١٣,٠

WPCP= Whey protein concentrate powder

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تأثير الاستبدال الجزئي للمادة الصلبة اللبنية بمسحوق مركز بروتينات الشرش في صناعة اللبنة بالترشيح الفائق

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يهدف هذا البحث لدراسة الخواص التركيبية والريولوجية والحسية للبنة المصنعة من اللبن الجاموسي المركز بالترشيح الفائق والتي استبدل فيها جزء من المواد الصلبة اللبنية بمسحوق مركز بروتينات الشرش للحصول على لبنه بخواص مناسبة وبتكاليف أقل. وقد تم صناعة اللبنة من اللبن الجاموسي المركز بالترشيح الفائق والمحتوى على جوامد كلية ٢٦% وبإضافة ٠,٥% ملح، كما تم إجراء استبدال جزئي للمادة الصلبة اللبنية مسحوق مركز بروتينات الشرش بنسب ١٠، ٢٠، ٣٠، ٤٠% لخفض تكاليف الانتاج.

وأظهرت النتائج حدوث إنخفاض في كل من نسب الدهن واللاكتوز وقيم الـ pH بزيادة نسب الإستبدال بينما حدث زيادة لكل من المحتوي البروتيني والرماد والحموضة بزيادة نسب الإضافة كما زادت نسب الحموضة والمحتوى من مركب الداى اسيتايل بزيادة فترة تخزين اللبنة في الثلاجة حتى ٢١ يوم بينما زاد المحتوى من الاسيتالدهيد حتى اليوم السابع فقط من التخزين وانخفض بعد ذلك.

وبالنسبة للخواص الريولوجية والخواص الحسية فقد أعطى استبدال الجوامد اللبنية بمسحوق مركز بروتينات الشرش بمستوى ١٠% لبنة ذات خواص مناسبة مشابهة لعينة المقارنة مع خفض تكاليف الانتاج. كما يمكن الاستبدال بمستوى حتى ٤٠% مع التخزين المبرد حتى سبعة أيام.

قام بتحكيم البحث

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