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Original paper

Impact of some ingredients and the processing method on composition and quality of probiotic Labneh

NABIL MEHANNA[1], SAMAR SALAMA[2*], MOHAMED ARAFA[2]

[1]Department of Dairy Science, Faculty of Agriculture, Kafrelsheikh University, Egypt
[2]Animal Production Research Institute, Agricultural Research Center, Giza, Egypt

Abstract This study aims to produce probiotic Labneh by following the probiotic bacteria counts in the presence of yoghurt starter culture and some ingredients used in making Labneh with two different methods. Probiotic Labneh was prepared by the traditional method (TM) and direct formulation method (DFM). In both methods, used skim milk powder (SMP) for treatments (A and C), while used a mixture (1:1) of whey powder (WP) and whey protein concentrate (WPC) was used for treatments (B and D). The results indicated that total solid (TS), fat, protein and ash had the lowest values ($P \leq 0.05$) in B treatment, whereas the differences between the rest treatments were insignificant ($P > 0.05$). Labneh made using the DFM had the lowest values for carbohydrate content and acidity and the highest pH values. The counts of Bifidobacteria and *L. acidophilus* were not influenced by the ingredients used or by the method applied for making the product. All fresh and stored Labneh had more than 6 log CFU/g for probiotic bacteria. Organoleptically, the general appearance, consistency and flavour of bio-Labneh were not significantly influenced by the applied treatments or by the manufacturing method but a gradual decrease in their scoring points were recorded with advancing storage period.

Keywords Manufacturing methods, probiotics, Labneh.

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*Corresponding author: SAMAR SALAMA, Postal address: El Tahrir to the Security Directorate / Kafr El-Sheikh Center, Postal code: 33511; Telephone: 00201065087975
E-mail: samarsalama1989@yahoo.com

Introduction

It is well-known that yoghurt has many desirable properties and longer keeping quality than milk but it still tends to spoil within a short time at ambient temperature. Many efforts were done from long time ago to improve the keeping quality of yoghurt even further by concentrating its solids via removing part of its water. Labneh (strained yoghurt) is considered a good example in this respect (ÖZER [1]). Labneh, Labaneh, Lebna and Labanah are all alternative expressions to Labneh which defined as a semi-sold spreadable product or concentrated yoghurt depending on total solids content (ÖZER [1]; TAMIME & al [2]). Manufacturing, properties, shelf life, nutritional values and labelling of commercial Labneh products were given in details in the literature (TAMIME & al [3]; TAMIME & al [4]; TAMIME & al [4]; NSABIMANA & al, 2005; ÖZER, 2006; TAMIME & al, 2014).

Labneh is well-known from long time ago as a fermented milk product with longer keeping quality than yoghurt. This product is derived from yoghurt by straining away part of its water and water-soluble components, mainly lactose and salts, using a cloth bags in the traditional method (TM) known also from long time ago.

Description, history, advantages and disadvantages of the use of the TM for making Labneh were reviewed – in details – by NSABIMANA & al (2005), ÖZER (2006). This TM is not suitable for modern dairy plants also for many reasons:

1. It needs a long processing time (2-3 days), **2.** It is labour-intensive, **3.** This method requires a large cooling space for manufacturing and storage, **4.** The quality of the product is not good enough and the product is unhygienic and finally **5.** The yield is low due to adherence of the curd to the cloth bags (TAMIME & al, 1989b and 1991c). However, more sophisticated methods using different procedures and modern technology were given in the literature by TAMIME & al (1989a and b), TAMIME & al (1991a and b).

NSABIMANA & al (2005), ÖZER (2006) and TAMIME & al (2014) reviewed the different processing methods of making Labneh including the TM, the mechanical separation method, ultrafiltration method and reconstitution/recombination method. ÖZER (2006) mentioned that quality of Labneh is greatly affected by the manufacturing method, whereas MEHANNA & al (2018) used the direct formulation method (DFM) in making a good quality probiotic Labneh.

In the current study, bifidobacteria and *L. acidophilus* culture were utilised in appropriate quantities to give the probiotic influence of Labneh. Viability of such bacteria in the presence of the traditional yoghurt starter culture used for fermentation is quite important, while survivability of the prementioned probiotic bacteria in the presence of some ingredients used for making Labneh as well as during processing time was also taken into consideration. Counts of the used probiotic bacteria are essential to give the required health benefits.

The objective of this study was to manufacture probiotic Labneh with good quality and longer shelf life using some ingredients and specific bacteria by traditional and direct formulation methods. A comprehensive comparison on composition and quality of the prepared Labneh made using the TM and DFM was also taken into consideration.

Materials and Methods

Fresh cow's milk was obtained from the station of Sakha Animal Production Research, Animal Production Research Institute. Low-heat SMP (Valio, LTD, Finland), WPC powder (Lactalis Ingredients, USA) and whey powder, WP (Portiant Dairy, Inc. USA) were purchased from the local market. Yoghurt starter (YC-XII-DVC) consisting of *S. thermophilus* and *L. delbruekii ssp. bulgaricus*, and used probiotic culture (ABT-2, Probio Tec., DVC) consisting of *Bifidobacterium* BB_{12}, *L. acidophilus* – LAS and *S. thermophilus* were purchased from Chr. Hansen Lab., Copenhagen, Denmark. Milk separator was used to obtain fresh sweet cream from cow's milk and used food salt from the market.

Labneh Manufacturing by the traditional method

Standardized cow's milk (4.0% fat) supplemented with 3% SMP (Treatment A) or 3% of mixture WPC and WP (1:1) (Treatment B) was used to prepare Bio-yoghurt. The prepared yoghurt milk was heat treated at 90°C/10 min, after that the yoghurt milk was cooled to 42°C then inoculation with yoghurt culture and probiotic starter (1:1). Fermentation was executed at 42°C to pH 4.5-4.6. This was followed by overnight cooling. The prepared bio-yoghurt was mixed and transferred into sterilized cloth bags, hanged in a refrigerator at 5±1°C to allow whey drainage for many hours. Sodium chloride (1%, w/w) was added to the bag contents, mixed thoroughly and the resultant Labneh was filled into plastic containers and cold stored. The traditional method (TM) described by TAMIME & al (1989b) was followed in this respect.

Labneh Manufacturing by the direct formulation method

Labneh was prepared from standardized cow's milk (14% fat) using SMP (Treatment C) or WP and WPC

powder (1:1) (Treatment D) to increase the percentage of total solids to about 28%. The obtained mixtures temperatures were raised by heating to 90℃ for 10 min, and then the mixtures were cooled to 42℃ to incubation. The yoghurt and probiotic cultures were supplemented to the prepared mixtures, and incubation was carried out until pH 4.6, during a period ranging from 6 to 8 hours. The obtained Labneh was salted (1%), then stored at 5±1℃ in a refrigerator. This method (FM) was described by ÖZER (2006) and TAMIME & al (2014).

Analytical methods

The analyses were carried out for the obtained bio-Labneh when the bio-Labneh was fresh and after 21 days of the storage period. These analyses were in terms of total solids (TS), fat, total protein (Kjeldahl method), and ash, as mentioned in AOAC (2005). The content of carbohydrate was calculated by the differences. The titratable acidity of the samples was determined as described in AOAC (2005). A digital pH meter was used for measuring the pH values.

Microbiological analysis

Bifidobacterium was counted using Deman Rogosa-Sharpe Agar (MRS) since agar was supplemented with glucose, cysteine, and lithium chloride. On the other side, *Lactobacillus acidophilus* was enumerated on (MRS) Basal agar supplemented with maltose (THARMARAJ and SHAH, 2003).

Sensory evaluation

Labneh samples were organoleptically scored by a regular score panel of some staff members of the pre-mentioned dairy departments as described by AMER & al (1997), including evaluation of flavour (60 points), consistency (30 points), and appearance (10 points).

Statistical analysis

The statistical analysis was executed using the SPSS 16.0 Syntax Reference Guide (SPSS, 2007) Inc. Chicago IL USA. The results were expressed as means with standard errors of the mean. Analysis of variance was carried out whereas Duncan's test was used to reveal the significant differences between the means as affected by the applied treatments and by the advancing storage time of the prepared product.

Results and Discussion

The chemical composition of fresh and stored bio-Labneh prepared by the TM and DFM is shown in Table 1. The obtained results indicated that the content of TS in all fresh and stored bio-Labneh samples recorded less than 28% for A, B, C and D treatments. Furthermore, the lowest TS value was recorded at B treatment compared with A, C and D treatments. This was right in fresh and stored samples. This may be attributed to the loss of moisture and the gradual increase in TS values increased during the period of storage. This increase recorded an insignificant effect ($P>0.05$).

The treatments C and D recorded insignificant differences between them in fat content. In contrast, fat contents in treatments C and D were always higher ($P\leq0.05$) than counterparts in treatments A and B. In all treatments, changing the storage periods recorded an insignificant effect ($P<0.05$).

The lowest value of protein content was recorded of Bio-Labneh prepared from treatment B, Table 1 shows that it contained 9.84% or a little higher value compared with A, C and D treatments of the same age. During the storage period, it was observed that a slight increase in TS content led to a slight increase in protein content.

Ash content showed a significant difference in treatments A and B, whereas the storage period had no significant effect on ash in C and D treatments. The results revealed that ash content followed the same trend of protein content but the changes during the storage period.

It is clear from Table 1 that the maximum values of carbohydrate content in bio-Labneh were recorded in A treatment compared with B, C and D treatments at any storage period. It may be of interest to note that the used starter culture consumed a huge quantity of lactose during fermentation that important to produce bio-Labneh with low-lactose content.

However, the use of WP and WPC had a pronounced impact on decreasing TS, fat, protein, ash and carbohydrate contents of the obtained bio-Labneh than the used SMP. This was more pronounced in case of applying the TM than DFM since the differences between A and B in this respect were statistically significant ($P\leq0.05$), while those between C and D were insignificant ($P>0.05$). The differences in composition and the physical properties of the SMP or mixture of WP and WPC seem to be responsible for the recorded differences. In the TM, the used cloth bags allowed loss of some components during the long time needed for drainage some whey and this by its turn was responsible for the differences in the present study. Concentration after (TM) or before (DFM) fermentation seems to be important factor in controlling the chemical composition of the prepared Labneh.

Applying the DFM allows controlling the chemical composition of the resultant Labneh since no drainage step

is needed, while in the TM a lot of dissolved constituents may be lost during the whey drainage and this by its turn affects the chemical composition of the final product. Most of the data given in Table (1) are in agreement with the ranges given by ÖZER (2006) according to the earlier studies done between 1987 and 1997. The ranges for Labneh were 23.3-26.1% TS, 9.2-11.9% fat, 7.7-10.5% protein, 0.6-1.8% ash and 3.6-5.1% lactose. Moreover, the present data are comparable to those given by TAMIME & al (1989a, 1991a, 1991b and 1991c) who used UF and by MEHANNA & al (2018) who applied the DFM in making probiotic Labneh.

Table 1. The chemical composition (%) of fresh and stored bio-Labneh prepared by traditional (A and B) and direct formulation methods (C and D), (Average ±SE of 3 replicates)*

Property	Storage (week)	Treatments			
		A	B	C	D
TS	Fresh	27.45±0.08^{aA}	25.81±0.02^{bA}	27.73±0.06^{aA}	27.67±0.05^{aA}
	1	27.51±0.04^{aA}	25.89±0.03^{bA}	27.79±0.03^{aA}	27.74±0.04^{aA}
	2	27.57±0.06^{aA}	25.93±0.02^{bA}	27.82±0.05^{aA}	27.80±0.02^{aA}
	3	27.60±0.07^{aA}	25.97±0.05^{bA}	27.84±0.04^{aA}	27.85±0.03^{aA}
Fat	Fresh	9.32±0.02^{bA}	9.18±0.01^{bA}	13.89±0.01^{aA}	13.90±0.00^{aA}
	1	9.37±0.01^{bA}	9.24±0.03^{bA}	13.91±0.00^{aA}	13.91±0.01^{aA}
	2	9.41±0.02^{bA}	9.28±0.03^{bA}	13.92±0.01^{aA}	13.91±0.00^{aA}
	3	9.44±0.04^{bA}	9.31±0.01^{bA}	13.92±0.01^{aA}	13.92±0.01^{aA}
Protein	Fresh	10.02±0.01^{aA}	9.84±0.02^{bA}	10.16±0.03^{aA}	10.13±0.01^{aA}
	1	10.08±0.01^{aA}	9.87±0.01^{bA}	10.16±0.03^{aA}	10.14±0.01^{aA}
	2	10.11±0.02^{aA}	9.89±0.00^{bA}	10.17±0.01^{aA}	10.15±0.01^{aA}
	3	10.13±0.01^{aA}	9.90±0.01^{bA}	10.18±0.02^{aA}	10.16±0.02^{aA}
Ash	Fresh	0.98±0.00^{aB}	0.87±0.00^{bB}	0.95±0.01^{aA}	0.94±0.01^{aA}
	1	0.98±0.01^{aB}	0.89±0.02^{bB}	0.95±0.01^{aA}	0.95±0.01^{aA}
	2	1.02±0.02^{aA}	0.90±0.01^{bB}	0.97±0.00^{aA}	0.95±0.00^{aA}
	3	1.03±0.01^{aA}	0.94±0.01^{bA}	0.98±0.01^{aA}	0.96±0.01^{abA}
Carboh-ydrate	Fresh	7.11±0.04^{aA}	5.92±0.03^{bA}	2.71±0.03^{cA}	2.69±0.02^{cA}
	1	7.07±0.02^{aAB}	5.87±0.2^{bAB}	2.75±0.03^{cA}	2.71±0.02^{cA}
	2	7.01±0.02^{aB}	5.84±0.01^{bB}	2.75±0.04^{cA}	2.75±0.03^{cA}
	3	6.97±0.04^{aC}	5.80±0.02^{bC}	2.75±0.04^{cA}	2.79±0.04^{cA}

* Averages with unlike small superscripts (due to treatments) and averages with capital superscripts (due to storage period) differed significantly (P≤0.05)

The results show that treatments A and B recorded the higher values of acidity in comparison with C and D treatments (P≤0.05) for the fresh and stored bio-Labneh, as shown in Table 2. In contrast, pH values had the opposite trend. The use of SMP as a supplement (treatments A and C) or mixture of WP and WPC (treatments B and D) had no significant impact on acidity and pH of the resultant Labneh. A decrease in the values of pH and an increase in the acidity values were recorded in all bio-Labneh samples during cold storage that were significant in all treatments. The acidity values increased due to converting the lactose to lactic acid (SINGH & al, 2011). During the storage period, all treatments recorded a significant decrease in pH values and an increase in acidity values because of the starter's enzyme activity added to bio-yoghurt. This was given by ÖZER & al (2007) and RANATHUNGA and RATHANAYAKA (2013). Acidity is an essential factor since it affects fermented dairy products' shelf life and acceptability (MAHMOUDI & al, 2014).

Most of the available studies concerned with making comparison between the traditional and UF-Labneh (TAMIME & al, 1989a, b; TAMIME & al, 1991b, c) but recently MEHANNA & al (2018) gave more details about composition and quality of Labneh produced using seven combinations of SMP and MPC (milk protein concentrate) to increase the TS content to about 26% with applying the DFM in the manufacturing process.

Table 2. Acidity (%) and pH value of fresh and stored bio-Labneh prepared by traditional (A and B) and direct formulation methods (C and D), (Average ±SE of 3 replicates)*

Property	Storage (week)	Treatments			
		A	B	C	D
Acidity	Fresh	1.52±0.01^{aD}	1.45±0.02^{aC}	0.93±0.01^{bC}	0.89±0.00^{bB}
	1	1.66±0.02^{aC}	1.53±0.01^{aB}	0.95±0.00^{bC}	0.92±0.00^{bB}
	2	1.78±0.01^{aB}	1.60±0.01^{aAB}	0.98±0.01^{bB}	0.94±0.01^{bB}
	3	1.86±0.02^{aA}	1.68±0.01^{aA}	1.02±0.00^{bA}	0.98±0.01^{bA}
pH	Fresh	4.41±0.03^{bA}	4.55±0.03^{bA}	4.57±0.02^{aA}	4.59±0.02^{aA}
	1	4.37±0.02^{bAB}	4.48±0.02^{bB}	4.52±0.02^{aB}	4.54±0.01^{aB}
	2	4.31±0.02^{bB}	4.40±0.02^{bC}	4.49±0.01^{aB}	4.51±0.01^{aB}
	3	4.28±0.02^{bB}	4.32±0.02^{bD}	4.44±0.02^{aC}	4.48±0.02^{aC}

* See footnote of Table (1) for details

Bifidobacteria *and L. acidophilus* counts (log CFU/g) of bio-Labneh are shown in Table 3. The applied treatments were not affected (P>0.05) their counts in bio-Labneh samples made by TM or DFM. The obtained data showed that the counts of bifidobacteria *and L. acidophilus* counts (log CFU/g) in treatments B and D were relatively (P>0.05) lower than the counterparts in A and C treatments respectively.

This suggests that presence of WP and WPC instead of SMP decreased the counts of bifidobacteria and *L. acidophilus* that may be attributed to existence of some antibacterial substances in the used whey products. It may be of interest to note such retarding impact was also previously noticed in the acidity data given in Table 2 since the values were significantly lower in all samples belonging to treatments B and D compared to those of treatments A and C. So, the use of WP and WPC decreased also activity of the bacteria used as a starter culture for the fermentation process.

However, the counts of probiotic bacteria were recorded a significant decrease by the end of the cold storage period. Fortunately, the counts of all bio-Labneh samples remained above 10^6 CFU/g. This indicates that the viability and counts of the used probiotic bacteria were adequate to cause a probiotic effect (GOMES and MALCATA, 1998). Such decrease in the counts agrees with the results given by MEHANNA & al (2018). It could be due to the impact of the corresponding increase in acidity and the decrease in pH during storage as previously given in Table 2.

Table 3. Counts of bifidobacteria and *L. acidophilus* (log CFU/g) of fresh and stored bio-Labneh prepared by traditional (A and B) and direct formulation methods (C and D), (Average ±SE of 3 replicates)*

Property	Storage (week)	Treatments			
		A	B	C	D
Bifido-bacteria	Fresh	7.08±0.05^{aA}	7.03±0.04^{aA}	6.92±0.05^{aA}	6.87±0.03^{aA}
	1	7.12±0.04^{aA}	7.09±0.03^{aA}	6.86±0.03^{aA}	6.82±0.04^{aA}
	2	7.05±0.04^{aA}	6.97±0.03^{aAB}	6.80±0.03^{aB}	6.76±0.05^{aAB}
	3	6.90±0.03^{aB}	6.84±0.04^{aB}	6.74±0.04^{aC}	6.71±0.04^{aB}
L. acidophilus	Fresh	6.98±0.03^{aB}	6.87±0.03^{aB}	6.88±0.02^{aA}	6.79±0.02^{aA}
	1	7.14±0.02^{aA}	6.98±0.02^{aA}	6.75±0.03^{aB}	6.69±0.03^{aB}
	2	7.00±0.02^{aB}	6.90±0.01^{aB}	6.70±0.02^{aB}	6.61±0.03^{aC}
	3	6.82±0.04^{aC}	6.72±0.02^{aC}	6.62±0.02^{aC}	6.54±0.02^{aC}

* See footnote of Table (1) for details

Concerning the organoleptic properties, most of the panelists accepted properties of the bio-Labneh made by the TM or DFM using SMP or mixture of WP and WPC. The differences in the given scoring points as shown in Table 4 for fresh Labneh due to the applied treatments were almost slight. The minimum and maximum scores given for appearance were 8.5 and 9 out of 10 points, whereas those for consistency were 27 and 28 out of 30 and those for flavour were 56 and 58 out of 60. Such slight differences were recorded during storage, while the scores gradually decreased with advancing storage reaching the minimum corresponding values at the end of storage. This agrees with the results given by SALEM & al (2007), EL-GANDOUR & al (2008), MEHANNA & al (2018) and EL-AHWAL & al (2019).

In general, the attained scoring points for the organoleptic properties are comparable to the maximum scores given by MEHANNA & al (2018) for their prepared Labneh.

Table 4. Organoleptic properties of fresh and stored bio-Labneh prepared by traditional (A and B) and direct formulation methods (C and D), (Average score ±SE of 10 panelists)*

Treatments	Storage period/week	Appearance (10)	Consistency (30)	Flavour (60)
A	Fresh	8.5 ± 0.12^{bA}	27 ± 0.22^{bA}	56 ± 0.24^{bA}
B		9 ± 0.10^{aA}	28 ± 0.31^{aA}	58 ± 0.26^{aA}
C		9 ± 0.11^{aA}	28 ± 0.30^{aA}	57 ± 0.27^{bA}
D		9 ± 0.13^{aA}	27 ± 0.25^{bA}	58 ± 0.31^{aA}
A	1	8.5 ± 0.14^{bA}	27 ± 0.27^{aA}	55 ± 0.19^{bB}
B		9 ± 0.09^{aA}	27 ± 0.28^{aB}	57 ± 0.21^{aA}
C		8.5 ± 0.12^{bAB}	27 ± 0.32^{aB}	55 ± 0.28^{bB}
D		8.5 ± 0.11^{bA}	27 ± 0.25^{aA}	56 ± 0.27^{abB}
A	2	8 ± 0.15^{aB}	26 ± 0.19^{aB}	52 ± 0.24^{bC}
B		8 ± 0.14^{aB}	26 ± 0.24^{aC}	55 ± 0.23^{aB}
C		8 ± 0.13^{aB}	26 ± 0.22^{aC}	52 ± 0.26^{bC}
D		7.5 ± 0.10^{bB}	26 ± 0.24^{aB}	54 ± 0.33^{aC}
A	3	7 ± 0.15^{aC}	24 ± 0.22^{aC}	51 ± 0.23^{bC}
B		7 ± 0.12^{aC}	24 ± 0.24^{aD}	53 ± 0.23^{aC}
C		7 ± 0.12^{aC}	24 ± 0.27^{aD}	50 ± 0.31^{bD}
D		7 ± 0.13^{aB}	24 ± 0.22^{aC}	50 ± 0.33^{bD}

* See footnote of Table (1) for details

Conclusions

It is evident from the present study that good quality probiotic Labneh can be produced by employing the direct formulation method and using skim milk powder or mixture of whey powder and whey protein concentrate (1:1) to increase the total solids content before fermentation in the presence of probiotic bacteria. The counts of such bacteria were always higher than the minimum counts required to give the health benefits of the product. Moreover, the use of DFM is necessary to reduce the processing cost and time and to improve quality of the resultant bio-Labneh. So, we recommended using DFM in making bio-Labneh. We look forward to using other by-products instead of SMP or WPC using DFM in making bio-Labneh.

Conflict of Interest

The authors have no conflict of interest to declare.

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