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Nutritional Evaluation of *Moringa Oleifera* Leaves in Feeding Dairy Cattle on White Cheese Technological Properties

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THE goal of this research was to investigate how the impacts of added moringa dry leaves (MOL) to dairy cattle rations on white cheese (MWC) technological properties. Fifteen Friesian cows were divided into 3 equal groups and fed their nutritional requirement according to their milk production. The first group was served as a control without added moringa (T1), the second and third groups were fed with added 40g and 60g moringa/ head/ day (T2and T3), respectively. Milk was obtained from the experimental cows after 30 days from feeding. The results indicated that cheese yield and contents of fat, total nitrogen (TN) and water soluble nitrogen (WSN) were higher significantly ($P<0.05$) for T3 than other treatments in fresh and at the end of the storage period. Total volatile fatty acids were almost similar the values in all treatments. Total plate counts of bacteria (TBC) were decreased being 9.67, 8.46, and 7.49 (log cfu / g) for cheese in T1, T2, and T3, respectively. *Escherichia coli* (*E. coli*) count was not detected in any treatment. The minerals content of cheese in T3 were increased in phosphorus and calcium. The cheese made from cow's milk in T3 were recorded the highest value of α-Linolenic (omega3, n-3) unsaturated fatty acids. Organolepetical properties of cheese in T3 were significantly higher**,** preferred and more acceptable than the other treatments. So, the present results indicated that adding MOL for dairy cattle ration resulting in a rise in the nutritional value of the cheese received.

Keywords: Dairy cattle, *Moringa oleifera*, White cheese, Fatty acids, Organolepetical properties.

Introduction

Protein, potassium, calcium, iron, B-carotene, and vitamin C are found in abundance in Moringa leaves. Anticancer properties, cardiovascular disease prevention, and liver disease prevention have all been described. Several studies have been conducted to manufacture dairy products such as soft cheese, labneh, and yoghurt using the dried leaves of Moringa oleifera [1- 3].

Workshops have recently been held to highlight the benefits of moringa oleifera leaves in Africa and other underdeveloped countries, where they are used to treat malnutrition, particularly in infants and nursing mothers [4[. Moringa has been promoted as natural nutrition for the tropics by three nongovernmental organisations. Moringa leaves offers a lot of benefits as a protein source, including the fact that it is a perennial plant that may be harvested numerous times throughout the growing season [4].

Fresh or dry moringa oleifera leaves can be provided with minimal difference in consumption. The nutritional content of dry moringa leaves can be preserved for longer periods of time [5]. The CP kg-1DM (214.80 to 216.20g), ADF kg-1DM (268.30 to 310.29 g), and NDF kg-1DM (347.1 to 381.8 g) are all contained in moringa leaves dried meal [6]. In Nicaragua, Moringa oleifera is used as an alternative feed for dairy cows. Moringa fresh leaf has been consumed by a variety of animals. Positive impact on goat feeding habits [7].

The goal of this study was to investigate how the impacts of added moringa dry leaves (MOL) to dairy cattle rations on white cheese (MWC) technological properties

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Material and Methods

The present study was carried out at the Sakha Animal Production Research Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture in partnership with the Department of Animal Production, College of Agriculture, Kafrelsheikh, Egypt.

Animals and feeding system

Fifteen Friesian cows were divided into 3 equal groups and fed their nutritional requirement according to their milk production. Cows were fed on ration consisting of 40% concentrate mixture and 60% roughages. The first group was served as a control without added moringa (T1), the second and third groups were fed with added 40g and 60g moringa/ head/ day (T2 and T3), respectively. Dry moringa oleifera leaves were obtained from National Research Center, Egypt. It contains 4.21% fat, 38.4% protein, 6.5% ash, 31.73% carbohydrate, 7.21%fiber and 11.5% moisture. Milk was obtained from experimental animals after 30 days from feeding. Milk contained 3.04% fat, 3.19% protein, 4.36% lactose, 8.10% solid not fat, and 11.14% total solids as determined by milko-scan, model 133B.

Cheese making

Standard microbial rennet powder (RENIPLUS 150G- Spain) was used in the manufacture of low salt white cheese (LSWC). Commercial edible grade table salt (sodium chloride) produced by El-Naser Company for salt was obtained from the local market. Calcium chloride ~~used~~ was obtained from El-Naser Company, Egypt.

Milk was divided into three batches according to the three dietary treatments. Each batch of 30 kg of milk heated (72°C for 15 s. and cooled to 37-40°C). Sodium chloride (4%), calcium chloride (0.02%), and (Rrniplus 150 G) rennet powder (3g/100 kg of milk) was added to the milk and stirred well, for cheese making using the conventional method [8]. Cheese blocks were stored in plastic containers under refrigeration (7±1°C) for 30 days. All the experiments cheese was replicated three times. Cheese yield = kg of cheese / kg of milk×100.

Physicochemical analyses

Samples of cheese were taken at different period (fresh, 7,15,30 days) and analysed for total solid, total nitrogen (TN), water soluble nitrogen (WSN), and fat were determined according to standard methods [9]. After 30 days of storage, cheese contents of microbiological, minerals, and fatty acids were measured.

Microbiological analysis

Total Coliforms count and E. coli were carried out according to El-Hadedy and Abu El-Nour [10]. Total viable bacteria were evaluated according to Houghtby *et al.* [11].

Minerals

Calcium by flam photometer, phosphorus by spectrophotometer and magnesium by atomic absorption were carried out [12].

Fatty acids

The GC model 7890 B from Agilent Technologies was equipped with flam ionization detector at central laboratories Network, NRC, Cairo Egypt.

Sensory Evaluation

The produced cheese's organoleptic qualities were evaluated by a test panel of ten people at the Sakha Animal Production Research Station, in collaboration with the Faculty of Agriculture in Kafrelsheikh, Egypt. The scheme proposed by Nelson and Trout [13]1981) is as follows.

Statistical Analysis

To evaluate the effect of therapy, the results were statistically analyzed using SAS in a complete design [14]. Duncan's Multiple Range Test Duncan [15] was used to test for substantial discrepancies between means.

Results and Discussion

Cheese yield:

It is clear from Table (1) that the milk obtained from cows fed moringa diets increased the yield of fresh white cheese as compared with that of the control. It is also observed that the fresh yield of treatment (T3) was higher than other treatments, which being 21.26, 22.64, and 23.53 for T1, T2 and T3, respectively. During the storage period, the yield of cheese was decreased in all treatments with advanced storage, which may be due to changes in the moisture content. These findings are partly in agreement with those reported by Salama *et al.* [16].

Physio-chemical properties of cheese:

The results of the physiochemical characteristics of white cheese are shown in Table (1). Cheese from T3 was a significantly higher ($P<0.05$) in fat content, TN and WSN than other treatments. The DM in treatment T3 was lower than in both the T2 and T1. During storage, the DM content of all treatments increased until the storage period ends. Differences in the DM content ran parallel with of the cheese yield, which indicated that the change in yield was inverse related to change in DM content. These findings corroborate previous findings reported by various workers [17, 18].

TABLE 1. Effect of physiochemical characteristics on white cheese samples at storage periods

Properties	Storage (day)	Treatments			Average ±SD
		T1	T2	T3	
Yield (%)	Fresh	21.26±0.03	22.64±0.03	23.53±0.02	$22.48±0.03^{A}$
	7	20.26±0.02	21.48±0.02	22.22±0.01	$21.32±0.02^{B}$
	15	19.98±0.02	20.21±0.02	20.14±0.02	$20.11±0.02^{C}$
	30	18.17±0.01	19.46±0.02	19.64±0.02	$19.09±0.02^{D}$
	Average ±SD	$19.92±0.02^{c}$	$20.95±0.02^{b}$	$21.38±0.01^{a}$	
DM (%)	Fresh	37.36±0.2	38.72±0.08	37.54±0.05	$37.87±0.1^{D}$
	7	39.56±0.2	40.73±0.04	38.91±0.02	$40.90±0.1^{C}$
	15	40.42±0.09	41.80±0.08	40.49±0.02	$41.24±0.1^{B}$
	30	43.69±0.08	44.49±0.2	42.83±0.05	$43.67±0.1^{A}$
	Average ± SD	$40.26±0.1^{b}$	$41.44±0.1^{a}$	$39.69±0.04^{c}$	
Fat (%)	Fresh	11.00±0.0	13.00±0.0	15.00±0.0	$13.00±0.01^{C}$
	7	15.10±0.1	15.67±0.2	15.20±0.1	$15.32±0.01^{B}$
	15	15.37±0.1	15.87±0.06	15.50±0.06	$15.70±0.07^{A}$
	30	15.83±0.1	15.90±0.0	15.70±0.06	$15.81±0.05^{A}$
	Average ± SD	$14.42±0.1^{c}$	$15.11±0.07^{b}$	$15.35±0.06^{a}$	
TN (%)	Fresh	1.86±0.02	1.98±0.01	1.86±0.01	$1.90±0.01^{D}$
	7	2.13±0.02	2.15±0.01	2.16±0.02	$2.15±0.02^{C}$
	15	2.26±0.01	2.29±0.02	2.54±0.02	$2.36±0.02^{B}$
	30	2.38±0.02	2.36±0.01	2.83± 0.01	$2.52±0.01^{A}$
	Average ± SD	$2.17±0.02^{b}$	$2.19±0.01^{b}$	$2.35±0.02^{a}$	
WSN (%)	Fresh	0.12±0.0	0.26±0.01	0.28±0.01	$0.22±0.01^{D}$
	7	0.27±0.01	0.32±0.01	0.38±0.02	$0.33±0.01^{C}$
	15	0.33±0.01	0.37±0.02	0.44±0.02	$0.38±0.02^{B}$
	30	0.44±0.02	0. 48±0.02	0.54±0.01	$0.49±0.02^{A}$
	Average ± SD	$0.29±0.01^{c}$	$0.36±0.02^{b}$	$0.41±0.02^{a}$	

Values are mean ± SD; T1: Control cows.T2: added 40 g moringa to feed cows. T3: added 60 g moringa .^{abcd}: Means with different letter among treatments in the same raw are significantly different, and ^{ABCD}Letters indicate significant differences between storage periods of cheese.

The average values of fat % were ranged between 14.42 and 15.35%, and the difference in fat content in all treatments were mainly due to the variation in moisture content of cheese.

Average of total nitrogen content of T3 was higher significantly (P<0.05) than T2, and T1 being 2.35, 2.19, and 2.17 respectively. Water Soluble nitrogen showed a wide variation in treatment (T3) and higher than in T2 and T1 as being 0.41, 0.36, and 0.29 % for T3, T2, and T1, respectively (P<0.05). During storage period, marked increase in TN and WSN was observed in cheese from all treatments till the end of storage period. This may be due to its high DM content, stimulating the enzymes activity and growth of microflora.

Data in Table (2) showed that the cheese of T3 was a significantly higher (P<0.05) in titratabe acidity, TN/DM, F/DM, and WSN/DM, than other treatments, whereas titratabe acidity was recorded about 0.32, 0.35, and 0.38 for T1, T2, and T3**,** respectively**,** and it was increased by increasing the storage period. Adding moringa (T2 and T3) was increased significantly (P<0.05) fat content, TN and WSN compared to the control group. On the other hand, the total volatile fatty acids were almost the same values in all treatments and Cheese yield was gradually improved as the storage period was prolonged, but it was not significantly effects (P<0.05). These results indicate that reducing salt level enhanced the fat lipolysis, and /or addition the increase in TVFA could be explain based on the fact that an increase in cheese proteolysis can serve as a precursor for the formation of certain volatile fatty acids [20].

TABLE 2. Effect of physiochemical characteristics on white cheese samples at storage periods

Properties (%)	Storage (day)	Treatments			Average ±SD
		T1	T2	T3	
T.A Titratabe acidity	Fresh	0.22±0.01	0.28±0.01	0.28±0.01	$0.26±0.01^{D}$
	7	0.32±0.01	0.29±0.01	0.36±0.01	$0.32±0.01^{C}$
	15	0.36±0.02	0.31±0.01	0.39±0.02	$0.35±0.02^{B}$
	30	0.38±0.01	0.52±0.01	0.52±0.01	$0.48±0.01^{A}$
	Average ±SD	$0.32±0.01^{c}$	$0.35±0.01^{b}$	$0.38±0.01^{a}$	
TN/DM	Fresh	4.98±0.02	4.88±0.02	4.90±0.04	$4.97±0.05^{C}$
	7	5.38±0.04	5.28±0.04	5.31±0.04	$5.35±0.03^{B}$
	15	5.59±0.04	5.48±0.04	6.27±0.03	$5.73±0.03^{A}$
	30	5.45±0.02	5.30±0.02	6.60 ±0.06	$5.73±0.04^{A}$
	Average ±SD	$5.39±0.03^{b}$	$5.23±0.03^{c}$	$5.92±0.04^{a}$	
Fat/DM	Fresh	29.44±0.2	33.54±0.02	39.07±0.04	$34.07±0.03^{C}$
	7	37.42±0.2	38.45±0.3	39.80±0.2	$38.22±0.2^{A}$
	15	38.04±0.2	37.95±0.2	38.29±0.1	$38.04±0.2^{A}$
	30	39.29±0.2	35.74±0.2	36.66±0.1	$35.93±0.2^{B}$
	Average ±SD	$36.05±0.2^{c}$	$36.42±0.2^{b}$	$38.67±0.1^{a}$	
WSN/TN	Fresh	6.45±0.06	13.98±0.5	14.14±0.6	$11.52±0.4^{D}$
	7	12.68±0.1	14.81±0.6	17.67±0.6	$15.05±0.5^{C}$
	15	14.60±0.3	14.57±0.5	19.21±0.7	$16.13±0.4^{B}$
	30	18.49±0.6	16.96±0.5	22.88±0.6	$19.43±0.4^{A}$
	Average ±SD	13.06±0.3c	15.08±0.5b	18.48±0.6a	
TVFA 0.10NaOH	Fresh	2.33±0.02	2.63±0.02	2.22±0.01	$2.41±0.01^{D}$
	7	4.61±0.02	5.28±0.05	2.33±0.02	$4.07±0.03^{C}$
	15	6.96±0.03	7.98±0.02	7.81±0.05	$7.58±0.03^{B}$
	30	10.63±0.2	12.78±0.03	10.94±0.03	$11.45±0.03^{A}$
	Average±SD	$6.15±0.07^{a}$	$7.17±0.03^{a}$	$5.83±0.03^{a}$	

Values are mean ± SD; T1: Control cows.T2: added 40 g moringa to feed cows. T3: added 60 g moringa .^{abcd}: Means with different letter among treatments in the same raw are significantly different, and ^{ABCD}Letters indicate significant differences between storage periods of cheese.

Microbiological analysis

Determination of the total bacterial counts (TBC), coliform count, and *E. coli* count in fresh and after 30 days of storage cheese samples are shown in Table (3). The highest count of TBC and coliform values were obtained in T1 (control) followed by the other supplemented treatments. Total plate counts of bacteria were 9.67, 8.46, and 7.49 (log cfu / g) for cheese made from T1, T2, and T3, respectively. The high phenolic component concentration and other antibacterial properties of moringa may have contributed to reduce bacterial population. The findings are consistent with those reported by Suzana Dona *et al.* [21], who found that a chemical element of moringa leaves exhibit antihypertensive, anticancer, and antibacterial properties.

TABLE 3. Microbiological analysis of white cheese at 30days storage periods.

Properties	Storage periods (day)	Treatments		
		T1	T2	T3
Total Bacterial counts Log (c.f.u/g)	Fresh	$9.67±0.2^{bB}$	$8.48±0.1^{bB}$	$7.79±0.2^{cB}$
	30	$10.58±0.3^{BA}$	$9.58±0.2^{bA}$	$8.39±0.1^{cA}$
Coliforms count (MPM/gm	Fresh	$240±0.2^{a}$	$43±0.2^{b}$	$14.01±0.1^{c}$
	30	ND	ND	ND
E.coli	Fresh	ND	ND	ND
	30	ND	ND	ND

Values are mean ± SD, $^{abc:}$ Means with different letters among treatments are in the same raw are significantly different, ^{ABCD}: Means with different letters indicate significant differences between storage periods and ND: not detected

During storage TBC was recorded the highest counts at 30 days of making cheese in all treatments when compared with the fresh which it was a significantly lower in all treatments. The changes in

TBC during storage might be attributed to the changes in the titratabe acidity which suppressed their growth. On the other hand, the coliforms count was clearly showed in the control cheese (T1) which recorded about 240 MPM / g, while it was lower in the other treatments (T2, and T3 respectively) On the other hand, it was not detected after 30 days from storage in all treatments, these results were in agreement with Milci *et al.* [22]. They observed that the total aerobic bacteria count decreased during storage. The data also indicated that the *E. coli* count was not detected in any treatment or any stage of the storage period. When stored in whey at room temperature, however, soft cheese, also known as wara in Nigeria, has a relatively limited shelf-life of two to three days [1]. In addition to preventing bacteria deterioration, it appears that the cheese's nutritional profile has enhanced as a result of its preservation. When moringa (T2 and T3) was added to whey and stored at room temperature, it improved the shelf life by 3-30 days. This is probably due to the sensitivity of coliforms and *E. coli* to the acidity developed in cheese and other metabolites present in all treatment cheese as a result of rennet action and microbial growth.

Data in Table (4) showed that the highest values of minerals content of cheese were observed in T2 and T3 compared with. The values of P, Ca, and Mg were 720, 430, and 70 mg /100 g were obtained in T3 at fresh cheese while these values were 880, 450, and 50 mg /100 g after 30 days storage period. The lower concentration of magnesium at 30 days storage period may be attributed to release of the mineral in whey due to shrinking of cheese curd. These results are in agreement with those reported by Abd-Rabou [23]. Calcium contents of the cheese samples increased gradually throughout the storage period. These data are disagreeing with those reported by Abdalla *et al*. [24] showed that calcium of the white soft cheese increased with the storage from day zero up to day 180. Abdel Razig [25] stated that the calcium content of the white cheese increased as the storage time progressed.

TABLE 4. Effect of mineral contents (mg /100 g) on white cheese samples at 30 days storage periods.

Properties (mg/100g)	Storage periods (day)	Treatments		
		T1	T2	T3
Phosphorus	Fresh	590[b]	690[a]	720[a]
	30	680[b]	790[a]	880[a]
Calcium	Fresh	350	410	430
	30	390	430	450
Magnesium	Fresh	60	70	70
	30	50	50	50

[abc:] Means with different letters among treatments are in the same raw are significantly different.

Free fatty acids

The addition of moringa in the rations of cows had an effect on the free fatty acids in white cheese (Table 5). Cows fed moringa had lower saturated FA levels in their cheese and higher unsaturated FA levels.

According to recent research, replacing saturated fatty acids (SFA) with unsaturated fatty acids (USFA) lowers the risk of coronary events and death because saturated FA lead to raise low-density lipoprotein concentration and hence blood cholesterol, but unsaturated FA had the opposite impact. The greatest value of Omega 3 -Linolenic in the cheese prepared from cow's milk fed T3 whereas it was recorded about 2.01, 2.95, and 3.93 for T1, T2, and T3, respectively, which would boost its nutritional value for humans. However, Linoleic (C18: 2c9, 12 (n-6) was not significant affected by supplemented moringa. Free fatty acids were higher by after 30 days storage period.

Kholif *et al.* [26] found that feeding a moringa leaves preparation to goats reduced the quantity of SFA and then the 6: n-3 ratio of USFA in milk while increasing the overall unsaturated FA content. The change in the FA profile of low salt white cheese that was discovered could be linked to phenolic species found in moringa additives in T2 and T3, which would be expected to inhibit the biohydrogenation process and, as a result, the growth of Butyrivibriofibrisolvens and Ruminococcusalbus, altering the FA profile of cow milk [27].

TABLE 5. Free fatty acids (g/100g total FA) on cheese at storage periods

Properties	Storage period (days)	Treatments		
		T1	T2	T3
Butyric (C4)	Fresh	1.53[b]	1.81[a]	1.87[a]
	30	1.62[b]	2.71[a]	3.20[a]
Caproic (C6)	Fresh	1.07	1.18	1.20
	30	1.89	2.15	2.23
2.257Caprylic (C8)	Fresh	2.47	2.56	2.70
	30	3.58	3.29	4.57
Capric (C10)	Fresh	3.06[a]	4.76[b]	5.45[a]
	30	4.11[b]	4.84[ab]	5.77[a]
Lauric C12)	Fresh	2.46	3.07	3.19
	30	2.69	3.35	3.84
Myristic (C14)	Fresh	9.91	10.31	11.69
	30	12.41	13.44	13.55
Palmatic (C16)	Fresh	33.82	36.18	37.03
	30	35.91	38.00	38.69
Stearic (C18)	Fresh	13.42[b]	15.88[a]	16.27[a]
	30	13.35[b]	16.61[a]	17.42[a]
Oleic (C18:1)	Fresh	28.74[b]	34.13[a]	36.24[a]
	30	36.42	34.99	37.75
Linoleic (C18: 2c9, 12 (n-6)	Fresh	3.37	3.34	3.40
	30	4.21	4.11	4.26
α-Linolenic (C18: 3c9, 15, 15, (n-3)	Fresh	2.01[c]	2.95[b]	3.93[a]
	30	2.90[c]	3.85[b]	4.83[a]

[abc:] Means with different letters among treatments are in the same raw are significantly different. T1: Control cows.T2: added 40 g moringa to feed cows. T3: added 60 g moringa

It is desired to have a larger content of polyunsaturated fatty acids (PUSFA) and a smaller amount of saturated fatty acids (SFA) in the diet [28]. As a result, its inclusion in the diet is advised since it prevents disease and promotes good health. More -linolenic acid ingestion, according to Wood *et al.* [29], promotes endogenous synthesis of long chain n-3 fatty acids. They're interesting because they're precursors of long-chain n-3 PUFA in the manufacture of eicosanoids, which are key bioregulators in a variety of cellular activities [30].They play a role in the immune system's development and function. Foods lows in (SFA) are preferred by consumers because they are linked to an increased risk of cardiovascular disease and various malignancies [31]. PUSFA consumption should be increased, according to human nutritionists [32].

Organolepetical properties

The results of sensory evaluation of product cheese were flavor, body & texture, appearance and total as judged by a panel showed in Table (6). The flavor, body & texture, appearance and total scores organoleptic were a significantly higher ($P<0.05$) in treatment T3 than the other treatments. The cheese made from T3 had recorded the higher of total score (89.78) followed by in order T2 (87.55) and T1 (79.36).The average of scores of organoleptic in the control group (T1) was measured the lowest value compared to the animals received moringa (T2 and T3), while the average score of sensory evaluation of cheese in T3 were higher value at fresh (91.03) than the control group (T1) at 30 days of storage periods (90.60). Cheese in T3 was mostly acceptable to the consumers and also recommended that adding moringa as T3 used to preserve of white cheese .The results are in harmony with Apilado *et al*. [33].

Conclusions

The results of the present study for manufactured white cheese resulted from cows fed moringa showed that cheese T3 supplemented with 60 g moringa was higher in cheese yield, and contents of fat, TN, DM, and WSN, than T2 supplemented with 40 g moringa and control ones. Moreover, cheese T3 can be resolving the problem of mineral deficiency for children in primary school. It is recommended to produce cheese in Egypt from fortification diet of cow by added moringa. Resultant cheese in T3 supplemented with 60 g moringa was preferred and more acceptable than control ones (T1). Adding moringa to feed of dairy cattle led to increase nutritional value of obtained cheese.

TABLE 6. Organolepetical properties on white cheese samples at Storage periods

Properties (%)	Storage (day)	Treatment			
		T1	T2	T3	Average ±SD
Flavor (60)	Fresh	42.77±0.06	54.50±0.1	58.10±0.1	$51.79±0.9^{A}$
	7	44.60±0.1	45.63±0.3	55.20±0.1	$48.48±0.2^{D}$
	15	46.10±0.1	49.20±0.1	53.60±0.1	$49.63±0.1^{C}$
	30	47.30±0.1	51.30±0.1	55.50±0.1	$51.37±0.1^{B}$
	Average ±SD	$45.19±0.09^{c}$	$50.15±0.2^{b}$	$55.60±0.1^{a}$	
Body &texture (30)	Fresh	25.70±0.1	26.80±0.1	24.33±0.3	$25.61±0.2^{D}$
	7	25.90±0.1	27.10±0.2	25.70±0.1	$26.23±0.3^{C}$
	15	26.10±0.1	27.70±0.1	26.20±0.1	$26.67±0.1^{A}$
	30	25.70±0.1	27.37±0.06	26.30±0.1	$26.46±0.2^{B}$
	Average ±SD	$25.85±0.1^{b}$	$27.42±0.4^{a}$	$25.63±0.2^{c}$	
Appearance (10)	Fresh	8.00±0.01	8.70±0.1	8.70±0.1	$8.47±0.1^{B}$
	7	8.20±0.2	8.57±0.2	8.50±0.1	$8.42±0.2^{B}$
	15	8.60±0.1	8.60±0.1	8.30±0.1	$8.50±0.1^{B}$
	30	8.57±0.2	8.70±0.1	8.80±0.1	$8.69±0.1^{A}$
	Average ±SD	$8.34±0.4^{b}$	$8.64±0.1^{a}$	$8.58±0.1^{a}$	
Total (100)	Fresh	76.37±0.1	90.00±0.2	91.03±0.3	$85.8±0.20^{AB}$
	7	78.70±0.2	87.30±0.2	89.40±0.3	$85.13±0.2^{B}$
	15	80.80±0.1	85.53±0.2	88.10±0.3	$84.81±0.2^{B}$
	30	81.57±0.2	87.37±0.1	90.60±0.2	$86.51±0.2^{A}$
	Average ±SD	$79.36±0.2^{c}$	$87.55±0.2^{b}$	$89.78±0.2^{a}$	

Values are mean ± SD; T1:Control cows.T2: added 40 g moringa to feed cows. T3: added 60 g moringa .^{abcd}: Means with different letter among treatments in the same raw are significantly different, and ^{ABCD}Letters indicate significant differences between storage periods of cheese.

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The authors declare that the present study has no financial issues to disclose.

Conflict of interest

None

Author's contributions

All authors contributed to the study's conception, and design. Data collection, examination and experimental study were performed by RMD, NBA, SAM and MAA. All biochemical analysis and data analysis were performed by MAA, RMD and ME. AEBG, NBA, NME and AHG drafted and corrected the manuscript; MAA and SAM revised the manuscript. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

References

1. Belewu, M**.**A, Zubair, M.F., Ogunleke, F.O., Busari, I.O. and El-lmam, A.A. Comparative evaluation of soft cheese treated with Moringa oleifera oil and pure natural honey. *International Journal of Academic Research*, **4**,130-134 (2012).
2. Salem, A.S., Salama, W.M., Hassanein, A.M. and El Ghandour, H.M. Enhancement of nutritional and biological values of Labneh by adding dry leaves of Moringa oleifera as innovative dairy products. World *ApplietScience Journal*, **22**, 194-1602(2013).
3. Hassan, F.A.M., Bayoumi, H.M., Abd El-Gawad, M.A.M. and Enab A.K. Utilization of Moringa oleifera leaves powder in production of yoghurt. *International Journal of Dairy Science*, **11**, 69-74 (2016).
4. Islam, Z., Rashadul Islam, S. M., Hossen, F., Mahtab-ul-Islam, K., Hasan, Md. R. and Karim, R. Moringa oleifera is a Prominent Source of Nutrients with Potential Health Benefits. *International Journal of Food Science*, 1-11 (2021).
5. Mendieta-Araica, B., Sporndly, R., Reyes-Sanchez, N. and Sporndly, E. Feeding Moringa oleifera fresh or ensiled to dairy cows effects on milk yield and milk flavor. *Tropical Animal Health and Production*, **43**, 1039 –1047(2011).
6. Sultana, N., Alimon, A.R., Huque, K.S., Sazili, A.Q., Yaakub, H., Hossain, J. and Baba, M. The feeding value of Moringa (Moringa oleifera) foliage as replacement to convention al concentrate diet in Bengal goats. *Advance Animal Veterinary Science,* **3**, 164-173(2015).
7. Manh, L., Dung, N.and Ngoi, T. Introduction and evaluation of Moringa oleifera for biomass production and as feed for goats in the Mekong Delta, Livestock Research for Rural Development,17, Retrieved December 7, 2010, from http://www.lrrd.org/ lrrd17/9/manh17104.htm.(2005).
8. Fahmi, A.H. and Sharara, H.A. Studies on Egyptian domiati cheese. *Journal of Dairy Research*, **29,** 99 (1950).
9. A.O.A.C. *Association of Official Analytical Chemists*. Official Methods of Analysis, 15 Ed., Washington, D.C., pp. 803-845(1990).
10. El-Hadedy, D. and Abu El-Nour, S. Identification of Staphylococcus aureus and Escherichia coli isolated from Egyptian food by conventional and molecular methods. *Journal of Genetic Engineering and Biotechnology*, **10** (1), 129-135 (2012).
11. Houghtby, G.A., Maturin, L.J. and Koening, E.K. Microbiologi count methods In: R.T. marshal (Ed). *Standard methods for the examination of dairy products* (16 Ed). American Public Health Association, Washington, D.C, USA. 213-246(1992).
12. Cottenie, A., Verloo, M., Kiekena, L., Velghe, G. and Camerlynck, R. Chemical analysis of plant and soil laboratory of analytical and agrochemistry, State University of Ghent. Belgium, pp: 100-129.
13. Nelson, J.A. and Trout G.M. *Judging of Dairy Products*, 4th Ed. INC Westport, Academic Press, 345-567 (1981).
14. SAS SAS Institute Inc. SAS User's Guide, Statistics. Cary, NC., USA (2004).
15. Duncan, D. B. (1955). *Multiple Range and Multiple F-Test*. Biometrics, 11, 1-42 (1982).
16. Salama, F.A., Ismail, A.A., Youssef, A.M. and Salem, S.A. Comparative studies on white cheese pickled Brinza cheese made from cows' and buffaloes' milk in Egypt. 11- Effect of picking condition. *Egyptian Journal of Dairy Science*, **10**:243 (1982).
17. Hofi, A.A., Nour, M. and El-Nagar, S. Chemical composition and quality of market cold stored soft cheese. *Egyptian Journal of Dairy Science*, **7**, 87 (1979).
18. Mehanna, A.S. and Rashed, M.A. An attempt to improve the keeping quality of Tallaga cheese by using milk treated with carbon dioxide. *Egyptian Journal of Dairy Science*, **18**:377 (1990).
19. Shehata, A.E**.**, Gaafar, A.M. and Gehan Hussein, A.M. Fate of enterotoxigenic S. aureus in Tallaga cheese. proc. 6th Egypt Conference Dairy Science and Tech., Cairo 4-6: 169 (1995).
20. Nakae, T.and Elliott, T.A. Elliott Production of volatile fatty acids by some lactic acid bacteria. 11-Selective formation of volatile fatty acids by degradation of amino acids. *Journal of Dairy Science*, **48**-298 (1965).
21. Suzana Dona, D. Franciscus, R. Andrajati, S. SantiPurna and Abdul M, Effect of moringa oleifera leaves extract against hematology and blood biochemical value of patients with iron deficiency anemia. *Journal of Young Pharmacists*, **9**, 79-84 (2017)**.**
22. Milci, S., Goncu, A., Alpkent, Z. and Yaygın, H. Chemical, microbiological and sensory characterization of Halloumi cheese produced from ovine, caprine and bovine milk. *International Dairy Journal*, **15**, 625-630 (2005).

23. Abd-Rabou. N.S. Effect of dietary zinc. Fortification on quality of Domiati cheese. *Egyptian Journal of Dairy Science*, **30**: 201-215 (2002).

24. Abdalla, M.I., El-Zubeir, I.E.M. and Hassan, F.A. Effect of Packaging Technique in Physicochemical Composition of Sudanese White Soft Cheese. *International Journal of Scientific Research Publ*., **3** (3), 2250-3153 (2013).

25. Abdel Razig, K.A. Quality attributes of braided cheese "Mudaffra" as affected by level of salt and storage temperature. Ph.D. Thesis, University of Khartoum, Sudan (2000).

26. Kholif, A.E., Gouda, G.A., Morsy, T.A., Salem, A.Z.M., Lopez, S. and Kholif, A.M. Moringa oleifera leaf meal as protein source in lactating goat's diets: Feed intake, digestibility, ruminal fermentation, milk yield and composition, and its fatty acids profile. *Small Ruminant Research*, **129**, 129–137 (2015).

27. Zhang, T., Si, B., Deng, K., Tu, Y., Zhou C. and Diao Q. Effects of feeding a Moringa oleifera rach is and twig preparation to dairy cows on their milk production and fatty acid composition, and plasma antioxidants. *Journal of Science Food Agriculture*, **98**, 661-666 (2018).

28. Hoffman, L.C. and Wiklund, E. Game and vension-meatfor the modern consumers. *Meat Science*, **74**, 197-208 (2006).

29. Wood, J.D., Enser, M., Fisher, A.V., Nute, G.R., Sheard, P.R., Richardson, R.I., Hughes, S.I. and Whittington, F.N. Fat deposition, fatty acid composition and meat quality: *A review Meat Science*, **78**, 343-358 (2008).

30. Khotimchenko, S.V. Lipids from the marine alga Gracilaria verruscosa. *Chemistry* of *Natural Compounds*, **41**(3), 285-288 (2005).

31. Griffin, B.A. How relevant is the ratio of dietary n-6 to n-3 polyunsaturated fatty acids to cardiovascular disease risk? Evidence from the OPTILIP study. *Current Opinion in Lipidology*, **19**, 57-62 (2008).

32. Alfaia, C.P.M., Alves, S.P., Martins, S.I.V., Costa, A.S.H., Fontes, C.M.G.A., Lemos, J.P.C., Bessa, J.B. and Prates J.A.M. (Effect of the feeding system on intramuscular fatty acids and conjugated linoleic acid isomers of beef cattle, with emphasis on their nutritional value and discriminatory ability. *Food Chemistry*, **114**, 939–946(2009).

33. Apilado, O.S., Maria, C.R.O., Ione, G.S. and Rosalina, M.L. Composition, sensory quality, and acceptability of cream cheese from pure buffalo's milk added with Malunggay (Moringa oleifera L.) leave Powder. *Philipp Journal of Veterinary Animal Science*, **39**,91-98(2013).

التقييم الغذائي لأوراق المورينجا أوليفيرا في تغذية الأبقار الحلابة على الخواص التكنولوجية للجبن الأبيض

محمد عوض أبو الحمد[1]، سعيد أحمد محمود[2] ،، نبيل بسيوني الجمل ، نبيل محمد عويضه[2] ، علي السعيد غديه و رشا ممدوح داوود[2]

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يهدف هذا البحث إلي معرفة تأثير إضافة أوراق المورينجا الجافة إلى عليقة أبقار اللبن على الخواص التكنولوجية للجبن الأبيض . تم استخدام خمسة عشر بقرة من أبقار الفريزيان الحلابة السليمة صحيا والخالية من أي عيوب ظاهرية أو صحيه حيث تم تقسيمها إلى 3 مجموعات متساوية طبقا للوزن وكمية إنتاجها من اللبن والحالة الفسيولوجية وتم تغذيتها وفقًا لإنتاجها من الحليب وحالتها الفسيولوجية .حيث كان يتم تغذية الأبقار الجلابة على علف يتكون من 40% خليط مركز و60% علف خشن. تم استخدام المجموعة الأولى كمجموعة مقارنة دون إضافة المورينجا (T1)، وتم تغذية المجموعتين الثانية والثالثة علي العليقة الاساسية مضافا لها 40 جرام و60 جرام من المورينجا (T2 و T3 /راس / يوم) على التوالي. أشارت النتائج إلى أن إنتاجية الجبن ومحتوياته من الدهن والـ TN وWSN للمجموعة الثالثة كانت أعلى من المعاملات الأخرى خلال فترة التخزين سواء الطازجة او نهاية التخزين. وسجل مجموع الأحماض الدهنية المتطايرة تقريبا نفس القيم في جميع المعاملات. بينما انخفض إجمالي عدد البكتيريا إلى 9.67 و8.46 و7.49 (log cfu/g) للجبن المصنوع من T1 وT2 وT3 على التوالي. لم يتم الكشف عن تواجد (E. coli) في أي معاملة. تم زيادة محتوى المعادن في الجبن في T3 في الفوسفور والكالسيوم. كما يحتوي الجبن المصنوع من حليب البقر الذي يتم تغذيته على T3 على أعلى في قيمة الأحماض الدهنية غير المشبعة (omega3 α-Linolenic، n-3) وقد أدى ذلك إلى تحسين قيمته الغذائية للاستهلاك البشري. كانت الخواص الحسية للجبن في T3 أعلى بكثير وكانت مفضلة وأكثر قبولا من المعالجات الأخرى. وهذا يعنى ان إضافة أوراق المورينجا الى علائق لعليقة الأبقار الحلابة يؤدي إلى ارتفاع القيمة الغذائية للجبن الابيض وخاصه عند اضافة 60 جرام مورينجا جافة يوميا لكل حيوان .

الكلمات الدالة: المورينجا أوليفيرا، الجبن الأبيض، الأحماض الدهنية، الخصائص الحسية العضوية.