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COMPOSITION AND SOME TECHNOLOGICAL PROPERTIES OF WATER BUFFALOE'S MILK AS AFFECTED BY DIETARY IODINE SUPPLEMENTATION

(With 8 Tables)

By

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تأثير اضافة اليود في العليقة على مكونات وبعض الصفـــات
التكنولوجية للبن في الجاموس

مصطفى قبيصي ، عصمت ابراهيم ، مسعد شتيـــــــــــوي

تأثير اضافة اليود في العليقة (٢ر٠ ملجرام يود في صورة يوديد بوتاسيـــــوم لكل كيلوجرام من وزن الجسم يوميا) على مكونات اللبن وبعض الصفات التكنولوجيـــة درست على عشرة من الجاموس في منتصف مرحلة الحليب . استمرت المعاملة باليـــود ٧ أسابيع وسببت زيادة في نسبة الدهن (P < .10) والبروتين (P < .08) والكازيـــن (P < .08) وبروتين الشرش (P < .05) واللاكتوز (P < .05) اضافة اليود أدت الي زيـــادة طفيفة في الكالسيوم (P < .10) والفوسفور (P < .07) بينما الكلور كانت نسبته متساوية تقريبا في لبن كل من الحيوانات المعاملة وغير المعاملة . نسبة الكلور على اللاكتـوز كانت عالية (P < .07) في اللبن الكنترول . كانت هناك زيادة معنوية (P < .05) فـي فيتامين A في لبن الحيوانات المعاملة . اللبن المحفوظ على درجة حرارة + ٢°م لمدة ٣ ، ٦ ، ٩ و ١٢ ساعة وجد أنه يحتوي على عدد أكبر من البكتريا وكذلك كانـــــت الحموضة أكثر في اللبن الكنترول . اختزال أزرق الميثيلين في اللبن الكنتـــــرول كانت أسرع عند كل فترات الحفظ . الزبادي المصنوع من اللبن الخاص بالحيوانـــات المعاملة باليود كان أكثر جودة .

SUMMARY

The effects of supplemental dietary iodine (.2 mg I as KI/kg BW daily) on milk composition and some technological properties were studeid in 10 mid-lactating water buffaloes. Iodine treatment continued for 7 wk and resulted in increased percentages of protein ($P < .08$), casein ($P < .08$), whey protein ($P < .05$), lactose ($P < .05$), Ca ($P < .10$),

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P ($P < .07$) and tended to increase fat% ($P > .10$). Chlorine did not differ ($P > .10$) between treatments and chlorine/lactose was higher ($P < .06$) in milk of control animals. Vitamin A was significantly ($P < .03$) increased due to I treatment. Total bacterial count as well as acidity of preserved milk at 20±2°C for 0, 3, 6, 9 and 12 h of the preservation period were found to be higher in milk of control animals than that of I-treated ones. The reduction of methelene blue in control milk was faster than that in milk of I-treated animals at all preservation periods. Yoghurt made from milk of I-treated buffaloes gained a higher quality and total scoring points.

(Key Words: Iodine, Buffaloe, Milk, Composition, Preservation, Yoghurt).

INTRODUCTION

Natural feed sources vary considerably in iodine (I) level and differ greatly by areas of the country and world. Some I has been added to dairy cattle rations to prevent iodine deficiency signs and to attempt to improve reproductive efficiency, milk production and perhaps correct other problems (HEMKEN, 1979). CONVEY, et al. (1977) found a slight increase in milk yield in cows that received 164 mg I/head daily compared to those receiving 16 mg and KOVAL'KOVA, et al. (1984) found that addition of 5 mg I daily to diet of the dairy cow had beneficial effects on milk production. Other studies (HEMKEN, et al. 1972) found no differences in milk yield of cows receiving either 6.8 or 68 mg I/head daily. Certainly, some added iodine will improve milk production if an iodine deficiency is present. The daily requirement of I for cattle is about 10 mg/20 kg dry matter (DM) intake (NRC, 1978). However, the upper level needed to maximize productivity is not clearly established (HEMKEN, 1979). In addition, Excess I is excreted in the urine and in the milk during lactation (PAYNE and PAYNE, 1987). Therefore, the objective of this study was to determine the effects of supplemental dietary iodine on composition and some technological properties of water buffaloes' milk.

MATERIAL and METHODS

Animals and Diet

A study was carried out in Animal Production Experimental Farm and Dairy Science Department of the Facutly of Agriculture, Assiut University. Ten Egyptian water buffaloes averaging 495 ± 27 kg body weight (BW) in mid-lactation (19th wk) were utilized in this study. Animals were chosen in mid-lactation because nutrient requirements are highest during this stage. The trial included 2 wk preliminary period and 7 wk experimental period. During these periods animals were individualy fed the same diet (Table 1) to cover the requirements of lactation in water buffaloes as suggested by GHONEIM (1967) and calculated according to BW and milk production. Animals were given 40% roughage (rice straw) and 60% concentrate (DM basis) to cover their requirements. The concentrate diet was offered twice daily just before milking. Water was offered to the animals three times during the day and was available all night hours. At the end of the preliminary period, animals were divided into two treatment groups similar in BW and milk production; a control group (A) receiving no I supplement and an I-treated group (B) receiving supplemental dietary I. The I dose was calculated on the basis of .2 mg 1/kg BW daily, but instead of dosing the animals daily, animals were given their respective doses only 2 times a week (i.e. weekly dose/2 on Sunday and again on Wednesday). Supplemental I was given in the form of KI dissolved in about 50 ml of water and spread over the concentrate diet just before morning feeding. Intake of supplemental I by treated animals averaged about 100 mg/head daily. Concentrates, roughages and water were not analyzed for I. Contribution of I from these sources was considered equal for the control and treated animals.

Sampling and Analytical Methods

Milk yield was recorded daily and individual milk samples as well as composite samples from evening and morning milkings were taken at wk 3, 5 and 7 of the experimental period. Milk fat, total protein, casein, total solids, chloride and acidity were estimated as described by LING (1963). Lactose content was measured according to International Dairy Federation (IDF; 1974). Chlorine/lactose (Koestler Number; K.N) was calculated as follows:

K.N = (chlorine% / lactose%) X 100. Total calcium was estimated as described by KOLAGENA and GRALTSTEVA (1973). Phosphorus was estimated spectrophotometrically (Unicum, sp. 1300) as molybednium blue, using hydroquinon-amonium molybedate as described by KOLAGENA and GRALTSTEVA (1973). Thereafter, the whole milk sample was digested using a mixture of nitric acid and sulphuric acid (1:1) and the clear digesta was diluted with distilled water before analysis. Vitamin A was determined (DAVIDOV, 1963) in the non-saponified fraction obtained by adding 10 ml of 95% ethanol and 10 ml of 60% KOH solution to 100 ml of milk.

Technological Properties

Composite milk samples were preserved in sterilized flasks and kept at 20±2°C. One composite sample of each group was analyzed at 0, 3, 6, 9 and 12 h of the preservation period. Total bacterial count (TBC), acidity, methelene blue test, alcohol precipitate test and clot on-boiling test were estimated as described by EL-SADEK and MAHMOUD (1967).

Yoghurt manufacture and quality: milk was heated at 85°C in water bath for 20 min, cooled to 40-42°C, inoculated with 2% yoghurt starter culture (1:1) (Str. thermophilus and L. bulgaricus) at 40°C for 3-4 h untill it was coagulated and then refrigerated overnight. Yoghurt samples were then analyzed for total solids, fat, acidity and suger percentages as described previously. The amino-N content was estimated using the formol titration method and calculated as mg N/100 ml. The total lactic acid bacteria count was carried out as recommended by the American Public Health Association (1972). Yoghurt samples were organoleptically evaluated by seven specialists following the Yoghurt Scoring Method (PEARCE and HEAP, 1974).

Statistical Analysis

Milk yield and constituents were analyzed by least-squares analysis of variance using the General Linear Model (GLM) procedure (SAS, 1987) for personal computers. The effects of treatment, animal within treatment, period (wk) and treatment x period interaction were determined in a split-plot analysis of variance appropriate for repeated measurements on the same animal (GILL and HAFS, 1971). Animal within treatment was used as the error term to test treatment effects across time periods. Whenever, a treatment x period interaction ($P < .10$) was detected. Means were compared within periods (STEEL and TORRIE, 1980).

RESULTS

Results are presented in Tables 1, 2, 3, 4, 5, 6, 7 and 8.

DISCUSSION

1 - Milk Composition:

Means of milk fat were slightly higher in I-treated animals compared to controls (Table 2). A treatment x period interaction ($P < .05$) was noted for total solids percentage. At wk 5 of the experimental period. Total solids% was higher in I-treated buffaloes compared to controls (Table 2). Protein% and yield in I-dosed buffaloes' milk was higher by 8 and 11%, respectively compared to control. Iodine treatment increased casein% and yield by about 8 ($P < .08$) and 14% ($P > .10$), respectively (Table 3). Whey protein% and yield (Table 4) increased, too, by about 11 ($P < .05$) and 14% ($P > .10$), respectively in favor of I-dosed buffaloes. Lactose% (Table 4) in milk of I-dosed buffaloes was higher ($P < .05$) than that of control (4.53 vs 4.17%).

The improvements of total solids and many milk constituents such as protein, casein, whey protein and lactose in I-treated buffaloes' milk may be due to increased thyroid hormone synthesis. KOBEISY and SHETAEWI (1992) found that I-treated buffaloes had 40% more ($P < .02$) serum tri-iodothyronine (T_3) at wk 7 of the experimental period compared to controls. Thyroid hormone increases heart rate and mammary blood flow, the proportion of cardiac output perfusing the udder is thus increases which, in turn, increases the amount of nutrients available for milk synthesis (DAVIS, et al. 1988).

Increases in Ca ($P < .10$) and P ($P < .07$) concentrations were observed in milk of I-treated buffaloes compared to controls (Tables 4 & 5). Chlorine did not differ ($P > .10$) between treatments and Chlorine/lactose was higher ($P < .06$) in milk of control animals compared to I-treated ones (Table 5). Vitamin A in milk is dependent upon the blood supply of the vitamin because the mammary gland can't synthesize it (SCHMIDT, 1971). Therefore, the increases in vitamin A content in I-treated animals' milk ($P < .03$, Table 5) is probably a consequence of increased mammary blood flow due to increased thyroid hormone level (DAVIS, et al. 1988). High level of vitamine A in milk is useful to suckling animals because it is involved in disease resistance (GARRET, et al. 1940; HANSEN, et al. 1946 and HUBER, et al. 1961).

II- Technological Properties:

1 - Milk preservation.

It is of interest to note the higher growth rate of total bacteria in milk of control animals than that of I-dosed animals (Table 6). This effect may be due to higher levels of I being excreted in I-treated animals'milk compared to control ones (CONVEY, et al. 1977; HEMKEN, et al. 1972 and PAYNE and PAYNE, 1987). Iodine has antibacteriocidal effect (BORDINA, 1974) which depressed the growth of bacteria in I-treated animals' milk. The same effect could be observed also in milk acidity which increased progressively by about 9.1, 18.2, 27.3 and 57.6% after 3, 6, 9 and 12 h of preservation, respectively in control animals'milk compared to 0, 4, 7, 11.6 and 33.7%, respectively in I-dosed animals'milk (Table 6). These results are in agreement with those reported by BORDINA (1974). In order to confirm the previous results, methelene blue, alcohol precipitate and clot on boiling tests were carried out. The reduction of methelene blue in milk of control animals was faster than that of I-dosed animals at all preservation periods (Table 6). According to FAHMY (1975), milk from I-dosed buffaloes take grade 'average' after 12 h of preservation, but milk of control animals take the same grade (average) only after 6 h of preservation. FAHMY (1975) gave a new standard table which can be used for evaluating and grading buffaloe's milk. He gave grades good, average and poor if the reduction time of methelene blue is more than 3 h, 1.5-3 h and less than 1.5 h, respectively. Alcohol precepitate and clot on boiling tests showed no differences between treamtments, with exception of a positive response of alcohol precepitate test after 6 h of preservation in control milk (Table 6). The stronger effect in milk of I-dosed buffaloes may be due to the slower growth rate of bacteria in that milk compared to controls.

2 - Yoghurt Quality.

Table 7 shows chemical analysis and bacterial count of yoghurt made from experimental animals'milk. Total solids, amino-N% and total bacterial count (TBC) in yoghurt manufactured from milk of I-dosed animals were higher than that of controls. These effects can be attributed to the higher total solids (18.35 vs 17.21%) and protein (3.61 vs 3.33%) in I-dosed animals'milk than controls, respectively (Tables 2 & 3). The increase of TBC in yoghurt of I-dosed animals was not expected because the milk of that group was highly resistant to bacterial growth (Table 6). This contradiction may be due to liberation of I during the heat treatment (85°C) of that milk. Fat/DM%, total N/DM% and sugar%, were not affected by treatment (Table 7). Meanwhile, the acidity of yoghurt made from milk of I-dosed animals exceeded that of control which might be attributed to the propagation of bacteria in the first compared to the control one. In general, it could be concluded that making yoghurt from milk of I-dosed animals gained a higher quality and total scoring points (Table 8).

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Table 1. Composition of Concentrate and Roughage (Rice Straw) Fed to Control and Iodine-Treated Buffaloes.

	Rice Straw	Concentrates
	% of DM	
Crude protein	2.9	11.9
Crude fat	1.4	3.5
Crude fiber	31.0	13.0
Nitrogen free extract	48.7	63.4
Ash	16.0	8.2
Organic matter	84.0	91.8

Table 2. Milk Yield, Total Solids(%) and Fat(%) in Water Buffaloes as Influenced by Supplemental Dietary Iodine.

Sampling Week	Milk Yield, Kg/head/d			Total Solids, (%)			Fat, (%)		
	Treatment[a,b]			Treatment[a,b]			Treatment[a,b]		
	A	B	S.E	A	B	S.E	A	B	S.E
3	5.59	5.81	0.10	17.06	17.15	0.44	7.48	7.32	0.27
5	5.34	5.41	0.10	17.21[c]	20.32[d]	0.44	7.37	7.68	0.27
7	4.79	4.90	0.10	17.37	17.59	0.44	7.60	7.90	0.27
Mean	5.24	5.37	0.39	17.21	18.35	0.54	7.48	7.63	0.32

[a] Values are least-squares means and S.E = standard error.
[b] Treatments: A = control; B = .2 mg I as KI/kg body weight.
[c,d] ($P<.03$).

Table 3. Milk Protein and Casein in Water Buffaloes as Influenced by Supplemental Dietary Iodine.

Sampling Week	Protein, (%)			Protein, kg/head/d			Casein, (%)			Casein Yield, kg/head/d		
	Treatment[a]			Treatment[a]			Treatment[a]			Treatment[a]		
	A	B	S.E	A	B	S.E	A	B	S.E	A	B	S.E
3	3.38	3.72	0.05	.187	.215	.004	2.73	3.00	0.03	0.15	0.17	0.003
5	3.28	3.57	0.05	.174	.192	.004	2.67	2.89	0.03	0.14	0.16	0.003
7	3.33	3.54	0.05	.159	.173	.004	2.69	2.86	0.03	0.13	0.14	0.003
Mean	3.33[b]	3.61[c]	0.10	.174	.193	.010	2.70[b]	2.91[c]	0.08	0.14	0.16	0.009

[a]Treatments: A = control; B = .2 mg I as KI/kg body weight.
[b,c] (P<.08).

Table 4. Milk Whey, Lactose and Chlorine in Water Buffaloes as Influenced by Supplemental Dietary Iodine

Sampling Week	Whey, (%)			Whey Yield, g/head/d			Lactose, (%)			Chlorine, Cl (%)		
	Treatment[a]			Treatment[a]			Treatment[a]			Treatment[a]		
	A	B	S.E	A	B	S.E	A	B	S.E	A	B	S.E
3	0.65	0.73	0.01	35.8	42.2	1.11	4.22	4.56	0.05	1.04	1.03	0.0
5	0.61	0.68	0.01	32.4	36.8	1.11	4.16	4.50	0.05	1.06	1.05	0.0
7	0.63	0.68	0.01	30.4	33.6	1.11	4.13	4.53	0.05	1.02	1.01	0.0
Mean	0.63[b]	0.70[c]	0.02	32.9	37.5	2.40	4.17[b]	4.53[c]	0.06	1.05	1.03	0.03

[a]Treatments: A = control; B = .2 mg I as KI/kg body weight.
[b,c] (P<.05).

Table 5. Milk Chlorine/lactose, Calcium, Phosphorus and Vitamin A in Water Buffaloes as Influenced by Supplemental Dietary Iodine.

Sampling Week	Cl/lactose			Calcium, mg%			Phosphorus, mg%			Vitamin A, I.U.		
	Treatment[a]			Treatment[a]			Treatment[a]			Treatment[a]		
	A	B	S.E	A	B	S.E	A	B	S.E	A	B	S.E
3	2.48	2.27	0.03	187	192	1.36	124	128	1.01	70.2	77.2	1.11
5	2.57	2.34	0.03	186	194	1.36	124	129	1.01	65.9	71.7	1.11
7	2.48	2.23	0.03	189	191	1.36	122	125	1.01	63.8	70.2	1.11
Mean	2.51[b]	2.28[c]	0.08	187[d]	192[e]	2.00	123[f]	127[g]	1.36	66.6[h]	73.0[i]	1.68

[a]Treatments: A = control; B = .2 mg I as KI/kg body weight.
[b,c] (P<.06), [d,e] (P<.10), [f,g] (P<.07), [h,i] (P<.03).

Table 6. Studies of Keeping Quality of Raw Milk Preservation at Room Temperature (20 ± 2 °C).

Treatment*	Preservation Period (h)				
	0	3	6	9	12
			Total bacterial count (TBC)		
A	$47x10^3$	$12x10^4$	$24x10^5$	$92x10^5$	$124x10^5$
B	$43x10^3$	$73x10^3$	$25x10^4$	$16x10^5$	$26x10^5$
			Acidity %		
A	.165	.180	.195	.210	.260
B	.172	.172	.180	.192	.230
			Acidity increase, %		
A	0	9.1	18.18	27.27	57.58
B	0	0	4.65	11.63	33.72
			Methelene blue test (h)		
A	4 55	3 20	2 25	1 25	0 45
B	5 30	4 55	3 45	2 50	1 30
			Alcohol precipitate test (APT)		
A	-	-	+	+	+
B	-	-	-	+	+
			Clot on boiling test		
A	-	-	-	-	+
B	-	-	-	-	+

*Treatment: A = control; B = .2 mg I as KI/kg body weight daily.

Table 7. Chemical Analysis and Bacterial Count of Yoghurt.

Item	Treatment*	
	A	B
Total solids%	15.91	16.17
Acidity	.785	.795
Fat/DM, %	46.38	46.38
Total N/DM, %	4.07	4.08
Sugar/DM, %	21.56	21.64
Total bacterial count	57.35×10^7	83.52×10^7
Amino N, mg%	38.53	43.51

*Treatment: A = control; B = .2 mg I as KI/kg body weight daily.

Table 8. Organoleptic Scoring of Yoghurt.

Item	Treatment*	
	A	B
Flavor, 5	4.0	4.3
Appearance, 5	4.0	4.3
Body and Texture, 5	4.5	4.5
Total, 15	12.5	13.1

*Treatment: A = control; B = .2 mg I as KI/kg body weight daily.