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CHEMICAL COMPOSITION AND BACTERIOLOGICAL QUALITY OF BULK MILK FOR MANUFACTURING

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ABSTRACT

Covering a period of one year, weekly samples from milk for manufacturing were collected to represent bulk milk of about 15-25 tons per day. The chemical analysis showed that the max. TS(14.3%), fat (4.52%), protein (4.37%), casein (3.33%), α_s-CN(1.97%), β-CN (0.75%), K-CN (0.39%), serum protein (0.98%) and lactose (4.8%) were recorded in Dec., Feb., Dec., Nov., Nov., Nov., Dec., Dec. and Aug in order. The corresponding min. percentages of 12.76, 3.97, 2.79, 2.18, 1.0, 0.38, 0.18, 0.37 and 4.4 were recorded in Jul., Oct., Aug., Aug., Sept., Aug., Feb., Sept. and Jul. respectively. Winter milk had the highest TS (13.74%), fat (4.4%), protein (3.83%), casein (7.86%), α_s-CN (1.51%), β-CN (0.63%), serum protein (0.7%) and lactose (4.66%). Summer milk had the lowest TS (12.89%), protein (3.04%), casein (2.23%), α_s-CN (1.12%), β-CN (0.46%) and lactose (4.59%).

Nitrogen distribution was significantly affected by month and season of the year. Bacteriologically, months and seasons of the year had a highly significant effect on total, proteolytic, lipolytic and colifom bacterial counts.

INTRODUCTION

The pattern of milk production and processing in Egypt may be became clear since 1955, where modern dairy industry was established by the government followed by a great contribution of the private sector after 1975. However, milk for manufacturing doesn't receive attention with respect to monthly and seasonal variations in composition and processing properties during the year.

In the litterateur comprehensive studies were given in this respect. In Canada, Szijarto et al. (1973) demonstrated variability of casein, serum protein and NPN in plant milk supply in Ontario during the year. In Ireland, Irish milk for manufacturing is produced predominantly from Spring-calving cows. O'Keeffe (1984) demonstrated that Irish Winter milk from a Spring-calving herd was less suitable for chessmaking than contemporary milk from anautumn-calving herd. In Scotland, Banks and Tamime (1987) followed the seasonal trends in the efficiency of recovery of milk fat and casein in cheese. The collected milk samples were from silo creamery milk at monthly intervals over a period of one year. In the USA, Bruhu and Franke (1991) analyzed collected data of milk composition and cheese yield from four California plants over a period of two years.

The pre-mentioned studies encouraged us to follow the natural variations in composition and quality of milk for manufacturing over a period of one year. Months and seasons of the year were taken in consideration.

MATERIALS AND METHODS

Milk Samples

Weekly milk samples used in the present study were taken from a collecting center belongs to a private sector in Quttor Town, El-Gharbia Governorate. The samples were collected to present bulk milk of about 15-25 tons per day. Such daily bulk was a main source for a private dairy plant in Quttor Town for making soft and hard cheese.

Chemical analysis of milk:

Total solids (TS)and fat were determined according to Ling (1963) whereas lactose was measured as described by Barnett and Abdel-Tawab (1957). Total nitrogen (TN), non-casein nitrogen (NCN), non-protein nitrogen (NPN) were determined by semi-micro Kjeldahl method as described by Ling (1963). Casein nitrogen (casein N) and serum protein nitrogen (serum protein N) were quantified by difference using the following equations :

Casein N= Total N – NCN
Serum protein N = NCN – NPN

The relative concentrations of the main casein fractions were firstly calculated in casein samples after electrophoresis on polyacrylamide gel (Thompson et al.1964, Mehanna 1990). The Bio-Rad Imagin Densitometer (Model GS-700, USA) was used in this respect. This was followed by calculation of casein fractions in milk samples on the basis of their casein content.

Bacteriological analysis:

Total bacterial count (TBC) was carried out using trypton glucose extract agar medium (APHA, 1978), proteolytic bacterial count (PBC) was done using nutrient agar medium (Oxide) as described by Chalmer (1962), whereas those of lipolytic bacteria (L PC) were counted according to the method of Berry (1933). Coliform bacterial count (CBC) was done using violet red bile agar medium as given by Chalmer (1962).

All data were statistically analyzed according to Steel and Torrie (1960).

RESULTS AND DESCUSSION

The results given in Table (1) show that the max. total solids (TS) content during the year recorded in Dec., whereas the min. one was given in Jul. and all TS averages were slightly fluctuant around the annual average of 13.29%. However, such differences were highly significant. The max. fat content was recorded in Feb, whereas the min. content was given in Oct. All averages were slightly fluctuated with insignificant differences around the annual average of 4.28%. Also, the foregoing data suggest that milk samples collected in Dec. had the max. protein content, followed by those of Nov., whereas samples of Aug. had the min. values. Such differences were highly significant. TN content (Table1) was the highest during Nov. and Dec. whereas the lowest value noted in Aug. and Sept. CN content showed nearly the same direction of results as TN. Such differences in TN and CN were highly significant.

Table (1): Monthly variations in chemical composition (%) of raw milk collected for manufacturing (Average of 4 replicates)

Constituent	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Total solids**	13.62	13.33	13.08	13.06	13.23	12.93	12.76	12.98	12.8	13.43	13.95	14.30
Fat *	4.37	4.52	4.22	4.27	4.30	4.25	4.25	4.40	4.40	3.97	4.15	4.30
Total protein**	3.83	3.29	3.20	3.43	3.31	3.19	3.14	2.79	2.91	3.89	4.23	4.37
Total N**	0.602	0.518	0.503	0.538	0.519	0.500	0.476	0.437	0.456	0.609	0.664	0.686
Casein N**	0.434	0.375	0.401	0.406	0.433	0.343	0.349	0.335	0.366	0.473	0.511	0.480
Non-casein N**	0.168	0.148	0.102	0.129	0.086	0.156	0.127	0.099	0.090	0.137	0.153	0.196
Non protein N*	0.050	0.045	0.029	0.030	0.026	0.029	0.035	0.036	0.031	0.036	0.041	0.044
Serum protein N**	0.117	0.100	0.073	0.102	0.060	0.129	0.092	0.063	0.059	0.100	0.112	0.152
Casein**	2.82	2.44	2.61	2.64	2.81	2.23	2.27	2.18	2.38	3.08	3.33	3.33
α_s – Casein**	1.52	1.39	1.53	1.36	1.60	1.05	1.28	1.05	1.00	1.19	1.97	1.62
β – Casein**	0.63	0.66	0.58	0.53	0.66	0.51	0.50	0.38	0.42	0.48	0.75	0.60
K – Casein**	0.24	0.18	0.20	0.38	0.33	0.31	0.33	0.20	0.29	0.38	0.35	0.39
Serum protein**	0.748	0.636	0.466	0.649	0.381	0.823	0.583	0.393	0.373	0.652	0.713	0.979
Lactose**	4.64	4.63	4.67	4.46	4.72	4.59	4.40	4.80	4.55	4.68	4.70	4.70

* Significant differences at $p < 0.05$
** Signlficant differences at $p < 0.01$
+ Non Significant

Different trends of results were given in the literature. For example Buzun *et al.* (1963) mentioned that the min. TS was recorded in Mar. and Apr., whereas the max. values were in Oct. and Nov., the corresponding min. fat contents were recorded in Mar. and Apr. and the max. in Oct. and Nov. However, Hafez (1982) and Saleh (1983) gave different trends. Such differences may be attributed to type of milk, feeding systems, stage of lactation and some environmental conditions (Othman *et al.* (1990); Habeeb *et al.* (1991).

Table (1) shows that the NCN had the lowest values in May, whereas the highest values were recorded in Jan. and Dec. On the other hand such values were greatly different from the annual average of 0.13%. Generally, month of year had a highly significant effect in this respect.

NPN was significantly ($p < 0.05$) affected by the month of the year, whereas such effect on serum protein N (SPN) was highly significant. Table (1) shows that the max. values of NPN and SPN were recorded in Jan. and Dec., whereas the min. contents were given in May and Sept. respectively. Szijarto *et al.* (1973) mentioned that the min. values of casein in Aug. Sept. and Oct. were accompanied by increased values of NPN.

Concerning casein and its fractions, Table (1) reveals that month of the year had a highly significant effect in this respect. Casein content followed nearly the same trend of the total protein. This was expected since casein is considered as the main protein in milk. However, milk of Nov. and Dec. was the richest in casein followed by milk of Oct., whereas the min. casein was recorded in Aug. and Jun.. In general the studies given by Szijarto *et al.* (1973)and Ng-Kwai-Hang *et al.* (1982) showed different trends of results.

Table (1) reveals that the highest average of α_s – casein was recorded in Nov. and Dec. and the lowest values in Jan. to Oct. β – casein had the max. and min. values in Nov. and Jun. to Oct. respectively. The min.

K – casein content was recorded in Feb. and the max. content was given in Dec. In this respect, Ng-Kwai-Hang *et al.* (1987) mentioned that month of the year had a highly significant effect on β - casein and K – casein.

Serum protein content varied widely during the year and month of the year had a highly significant effect in this respect (Table 1). Thus milk samples of Dec. were rich in serum protein whereas milk of May and Sept. was poor in this respect. Szijarto *et al.* (1973) found that the min. serum protein was recorded in Jan. and Feb., whereas Ng-Kwai-Hang *et al.* (1982) reported that this protein showed an increasing trend from Jul. to Dec..

Table (1) reveals that lactose content was the max. in Aug, whereas milk of Jul. had the min. lactose content. The differences in this respect due to month of the year were highly significant.

Effect of seasonal variation in chemical composition of raw milk is represented in Table (2). TS content was the highest in winter and the lowest in summer and the differences in TS were highly significant. This is in agreement with the results of Othman *et al.* (1990).

The max. fat content was recorded in winter followed by insignificant lower value in summer and spring, whereas the lowest content was given in autumn.

These results agree with the findings given by Othman *et al.* (1990). Total protein content was the highest in winter followed by values of autumn, spring and summer respectively. Such differences were highly significant. TN content followed the same trend, whereas, casein N had the max. value in autumn and the min. value in summer. Season of the year had a highly significant effect on TN and CN. These results agree -in part- with those given by Trafinov and Vladimirova (1964). However, Othman *et al.* (1990) found that protein content in summer was higher than that of winter.

Table (2): Seasonal variations in chemical composition (%) of raw milk collected for manufacturing (Average of 12 replicates)

Constituent	Season				F. value	P <
	Winter	Spring	Summer	Autumn		
Total solids	13.74	13.12	12.89	13.39	6.15	0.01
Fat	4.40	4.27	4.30	4.17	0.83	NS *
Total protein	3.83	3.31	3.04	3.67	8.05	0.01
Total N	0.602	0.520	0.470	0.576	8.2	0.01
Casein N	0.430	0.413	0.342	0.450	8.64	0.01
Non-casein N	0.169	0.106	0.127	0.126	8.00	0.01
Non protein N	0.047	0.028	0.033	0.036	7.44	0.01
Serum protein N	0.124	0.068	0.095	0.091	6.00	0.01
Casein	2.86	2.69	2.23	2.85	7.44	0.01
α_s – Casein	1.51	1.50	1.12	1.39	4.75	0.01
β – Casein	0.63	0.59	0.46	0.55	3.53	0.05
K – Casein	0.27	0.31	0.28	0.33	1.00	NS
Serum protein	0.704	0.499	0.602	0.579	1.32	NS
Lactose	4.66	4.62	4.59	4.63	0.39	NS

*NS = Non significant

Table (2) shows that NCN and NPN followed fluctuant trend of results. Thus, the highest values were recorded in winter while the lowest values were given in spring. Such differences were highly significant. The max. percentage of SPN was recorded in winter whereas the min. one was given in spring.

Values of summer and autumn were nearly similar. However, such differences in SPN were highly significant.

Casein content was the max. in winter and autumn and significantly decreased in spring and summer. α_s – Casein and β – Casein followed the same trend of results being high in winter and low in summer. The differences due to season of the year were highly significant and significant in order. Such results agree –in part- with those given by Donnely and Barry (1983) and Kroeker *et al.* (1985). However, insignificant effect was recorded with respect to k -casein. The max. content was recorded in autumn, whereas, the min. one was given in winter. This agrees with that given by Kroeker *et al.* (1985). Serum protein content showed different trend being high in winter and summer and low in spring and autumn. However, such differences were insignificant. The recorded percentages of lactose were insignificant different.

Table (3): Monthly variation in bacteriological quality of raw milk collected for manufacturing (Average of four replicates)

Month	TBC ($\times10^6$)	PBC ($\times10^4$)	LPC ($\times10^2$)	CBC ($\times10^4$)*
Jan.	23.45	119.25	1.75	31.07
Feb.	14.97	110.0	3.57	20.50
Mar.	25.92	104.50	2.22	14.77
Apr.	26.70	134.00	4.50	30.62
May	48.42	110.75	79.75	30.32
Jun.	99.97	205.0	77.5	60.55
Jul.	76.75	245.5	32.75	90.50
Aug.	211.0	202.25	55.00	115.75
Sept.	163.75	139.25	6.50	164.45
Oct.	46.12	127.75	14.75	133.00
Nov.	30.27	65.25	8.25	30.65
Dec.	15.55	87.25	0.75	18.25
Significant Level	0.01	0.01	0.01	0.01

*TBC represents total bacterial count, PBC represents proteolytic bacterial count, LBC represents lipolytic bacterial count, CBC represents coliform bacterial count in order.

Table (3) shows the total bacterial (TBC) significantly affected by month of the year. As expected the highest counts was recorded in Aug., whereas milk of Dec., Jan. and Feb. had much lower counts. Prteolytic bacterial count (PBC) was the highest in Jul. and very high in Jun. and Aug., whereas, samples of Nov. had the lowest counts. Such differences were highly significant. All milk samples during the year had much lower lipolytic bacterial count (LBC) than the corresponding PBC. The milk samples of Dec. and Jan. had the lowest LBC, whereas, samples of May and Jun. had the highest counts. Concerning coliform bacterial count (CBC), the max. numbers was observed in Sept. followed by those of Oct. and Aug. respectively, whereas the min. counts were recorded in Mar. however, month of the year had a highly significant effect in this respect.

Table (4) shows that the summer samples had the max. TBC, PBC and LBC, whereas, the min. counts were recorded in winter. Such differences in all groups were highly significant. On the other hand, CBC was the max. in autumn followed by those of summer, spring and winter respectively. Highly significant differences were recorded in this respect. These results for seasonal variation were expected since the long hot summer in Egypt helps naturally in gross and increasing the number of different bacteria. Moreover, it is well known that the poor quality of summer milk in Egypt as well as the poor keeping quality of such milk is mainly due to rapid souring.However, the present dada reflect the importance of clean production and cooling of summer milk in Egypt.

Table (4): Seasonal variations in bacteriological quality of raw milk collected for manufacturing (Average of 12 replicates)

Property*	Season				F. value	P <
	Winter	Spring	Summer	Autumn		
TBC ($\times 10^6$)	17.99	33.68	129.24	80.05	8.96	0.01
PBC ($\times 10^4$)	105.50	116.42	217.58	110.75	16.78	0.01
LPC ($\times 10^2$)	2.02	28.82	55.08	9.83	6.95	0.01
CBC ($\times 10^4$)*	23.28	25.24	88.93	109.37	9.60	0.01

* See legend to Table (3) for details.

REFERENCES

American Public Health Association. APHA. (1978). Standards Methods for the Examination of Dairy Products. 14th Ed. APHA, Washington, USA.

Banks, J. M. and A. Y. Tamime (1987). Seasonal trend in the efficiency of recovery of milk fat and casein in cheese manufacture. J. Soc. Dairy Technol., 40:64.

Barnett, A. J. and G. Abd El-Tawab (1975). A rapid method for determination of lactose in milk and cheese J. Sci. Food Agric., 8:437.

Berry, J. A. (1933). Studies on bacteriological flora and keeping quality of pasteurized liquid cream. J. Dairy Res., 15:1947.

Bruhn, J. C. and A. A. Franke (1991). Raw milk composition and cheese yield in Californis: 1987 and 1988. J. Dairy Sci., 74: 1108.

Buzun, I.; A. Khasina; N. Novikova and G. Vodyanitskaya (1963). Quality of milk for cheese making. Mol. Prom. 24:38. C. F. Dairy Sci. Abst. 25(1492).

Chalmer, C. H. (1962). Bacteria in Relation to the Milk Supply. 4th Ed., Edward Arnold Ltd., London.

Donnelly, W. J. and J. G. Barry (1983). Casein compositional studies. III Changes in Irish milk for manufacturing and role of milk proteinase. J. Dairy Res., 50:433.

Habeeb, A. A.; M, Kh. Ibrahim and A. H. Hiekal (1991). Environmental heat exposure effect on biosynthesis of milk components and some hormones in Friesian cows, Egyptian J. Dairy Sci., 19:131.

Hafez, E. H. (1982). Detailed composition of Friesian milk and its relation to some technological aspects. Ph. D. Thesis, Fac. Of Agric., Ain-shams Univ.

Kroeker, E. M.; K. F. Ng-Kwai-Hang; J. F. Hayes anf J. E. Moxley (1985). Effect of environmental factors and milk protein polymorphism on composition of casein fraction in bovine milk. J. Dairy Sci., 68:1752.

Ling, E. R. (1963). A Text Book of Dairy Chemistry Vol. 11 3rd Ed. Chapman and Hall Ltd., London.

Mehanna, N. M. (1990). Heterogeneity and genetic variants of casein and whey proteins from buffalo's milk. Egyptian J. Food Sci., 18:339.

Ng-Kwai-Hang, K. F.; J. F. Hayes; J. E. Moxley and H. G. Monardes (1982). Environmental influences on protein content and composition of bovine milk. J. Dairy Sci., 65:1993.

Ng-Kwai-Hang, K. F.; J. F. Hayes; J. E. Moxley and H. G. Monardes (1987). Variation in milk protein concentration associated with genetic polymorphism and environmental factors. J. Dairy Sci., 70:563.

O'keeffe, A. M. (1984). Seasonal and lactational influences on moisture content of Cheddar cheese. Irish J. Food Sci. Technol., 8:27.

Othman, A. B.; G. M. F. Edress and M. A. Amer (1990). The influence of seasonal and regional variation on the chemical analysis of cow milk constituents. Egyptian J. Food Sci., 18:283.

Saleh, Th., M. A. (1983). Studies on some chemical properties of buffalo's milk. M. Sc. Thesis, Fac. Of Agric., Tanta Univ., Kafr El-Sheikh.

Stell, R. G. D. and J. H. Torrie (1960). Principles and Procedures of Statistics. Mc Graw-Hill Book Comp., Inc. New York.

Szijarto, L.; D. A. Biggs and D. M. Irvine (1973). Variability of casein serum protein and non-protein nitogen in plant milk supplies in Ontario J. Dairy Sci., 56:45.

Thompson, M. P.; C. A. Kiddy; J. O. Johnston and R. M. Weinberg (1964). Genetic polymorphism in casein of cow's milk. 11. Confirmation of the genetic control of β – Casein variation. J. Dairy Sci., 47:378.

Trofimov, G. I. And A. V. Vladimirova (1964). Composition of milk supplies to dairy plants in Turkmen. Trudy Turkm. Sel. Khoz. Inst. 13:142. C. F. Dairy Sci. Abst., 29 (755).

دراسه تفصيليه على التركيب الكيمـــائى والجـــوده البكتيريولوجيـــه للبـــن المعـــد للصناعه

نبيل محمد مهنا ، رشاد إبراهيم الأحول ، هيام الجزار ، محمد إلهامى

تهدف الدراسه إلى تقديم صورة شامله عن اللبن المعد للصناعه حيث تم أخـــذ عينـــات إسبوعيه من اللبن المجمع بكميات تراوحت ما بين ١٥ – ٢٥ طن وأظهرت نتائج التحليل الكيمائى أن أعلى قيم للمواد الصلبه الكليه (١٤,٣ %) والدهن (٤,٥٢ %) والـــبروتين (٤,٣٧ %) والكازين (٣,٣٣ %) والألفا إس كازين (١,٩٧ %) والبيتا كازين (٠,٧٥ %) والكاباكازين (٠,٣٩ %) وبروتين السيرم (٠,٩٨ %) واللاكتوز (٤,٨%) وقد سجلت فى شهر ديســـمبر ، فـــبراير ، ديسمبر ، نوفمبر ، نوفمبر ، نوفمبر ، ديسمبر ، ديسمبر ، أغسطس على الترتيب وكانت أقل قيـــم مرتبطه بالقيم السابقة هـــى علـــى التوالـــي ١٢,٧٦ ، ٣,٩٧ ، ٢,٩٧ ، ٢,١٨ ، ١,٠٠ ، ٠,٣٨ ، ٠,١٨ ، ٠,٣٧ ، ٤.٤ قد سجلت فى شهور يوليه ، أكتوبر ، أغســـطس ، أغســـطس ، ســـبتمبر ، أغسطس ، فبراير ، سبتمبر ويوليه على الترتيب وقد أظهر لبن الشتاء أنه أعلى فى المحتوى مـــن المواد الصلبه الكليه (١٣,٧٤%) والدهن (٤.٤ %) والبروتين (٣,٨٣ %) والكـــازين (٢,٨٦ %) والألفا إس كازين (١,٥١ %) والبيتاكازين (٠,٦٣ %) وبروتين السيرم (٠,٧%) واللاكتوز (٤,٦٦%) وإحتوى لبن الصيف على أقل قيم من المواد الصلبه الكليـــه (١٢,٨٩%) والـــبروتين (٣,٠٤%) والكازين (٢,٢٣%) الألفا إس كازين (١,١٢%) والبيتاكـــازين (٠,٤٦%) واللاكتـــوز (٤,٥٩%) وقد تأثر توزيع النيتروجين معنوياً بشهور وفصول السنه ومن الناحيه البكتريولوجيه فقد كان لكل من شهور وفصول السنه تأثيراً عالى المعنويه على عدد البكتيريا الكلى والمحلله للبروتين والمحلله للدهن وكذلك مجموعة القولون وكانت أردأ عينات اللبن تلك الخاصـــه بفصـــل الصيـــف وأفضلها الخاصه بفصل الشتاء.