

THE EFFECT OF DIFFERENT STORAGE CONDITIONS
ON THE COMPOSITION AND KEEPING QUALITY OF PROCESSED
MILK

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SUMMARY

Samples of four major brands of tinned evaporated milk purchased from the local markets in Ibadan and cartons of pasteurized fresh milk from the Iwo Road dairy were left sealed or unsealed after opening. The samples were then stored on the shelf, in a bowl of water or in a refrigerator (storage conditions commonly used in many Nigerian homes). At 0, 24, and 48 hours, the samples were assessed for percentage fat and protein as well as bacterial quality using the plate count and the dye reduction tests.

The results showed that percentage milk fat remained unchanged after 48 hours of storage under the different conditions. Changes in percentage milk protein were also minor. Keeping quality in terms of total counts and dye reduction times, were poorest under shelf storage and best under refrigeration. Sealing the samples resulted in better keeping quality.

INTRODUCTION

In Nigeria, milk is consumed largely in the form of tinned evaporated milk and to a lesser extent, as pasteurized fresh milk, especially by a small section of

the population who live near ministry of agriculture and other institution dairies in the urban areas.

The popularity of evaporated milk stems from the fact that it lends itself to easy storage for many families who do not possess the facilities for refrigeration. When a tin of evaporated milk is opened, the common practice in many homes is to store whatever is left unused on the kitchen shelf, in a bowl of water, or in a refrigerator for periods ranging from 12 to 48 hours. The milk may become sour or sometimes may keep for 36 to 48 hours with little apparent undesirable changes.

There is at present no precise knowledge of the changes that take place in the milk, both bacteriological and nutritional, during storage under the different conditions used.

The study reported here was therefore undertaken to assess some of the changes that may occur in the keeping quality and chemical composition of processed milk when stored under conditions similar to those used in many Nigerian homes

EXPERIMENTAL

Two types of processed milk were studied: (a) evaporated milk in 170-gramme hermetically sealed tins and (b) pasteurized fresh milk in quarter-litre cartons. The evaporated milk was purchased from the local markets, while the pasteurized milk was obtained from the Ministry of Agriculture dairy, Iwo Road, Ibadan.

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Experimental Treatments:

The tins of evaporated milk were punched open at two points on the top surface, whilst the cartons of pasteurized milk were opened at a pre-punched hole at the side of the top. The samples were then divided into two with one half resealed with small pieces of white paper, whilst the other half were left unsealed.

The tins and cartons were then stored in one of three locations as is commonly done under local household conditions in Nigeria: (i) on the shelf, (ii) in a bowl of cool water placed on the shelf, (iii) in the food compartment of a domestic refrigerator.

Milk Sampling:

The tins of milk were cleaned thoroughly to remove all dust and dirt, the contents thoroughly shaken and two holes punched on opposite sides of the top surface of the tins with a sterile opener. The amount of milk required for each test was then withdrawn with a sterile pipette, taking aseptic precautions.

The milk in the cartons was thoroughly mixed before the cartons were opened and test samples obtained under aseptic conditions.

Bacteriological and Chemical Tests:

Each treatment sample was assessed for bacteriological quality using the standard plate count, methylene blue reduction test and the resazurin test as outlined by the APHA (1953).

The standard plate count was obtained on yeastrel milk agar and incubating for 48 hours at 37°C, at the end of which counts were made.

The methylene blue reduction test and the resazurin test were also carried out to estimate keeping quality.

Determination of the percentage fat and protein in milk were carried out according to the AOAC (1970) methods.

All the tests were carried out on each duplicate sample at three time intervals of 0, 24 and 48 hours.

Each type of milk was examined on a total of twelve times over a 24-week period from November 1975 to May 1976. The four brands of evaporated milk used were 'Peak', 'Coast', 'Black & White' and 'Rainbow'.

RESULTS

The standard plate count results are shown in Table 1. All the samples had very low average counts (1000 - 2000 organisms/ml) at the onset, but counts increased as the period of storage was prolonged. At 48 hours, all the brands of milk stored on the shelf and in water gave very dense growths, indicating considerable deterioration.

With the exception of the 'Coast' and 'Rainbow' samples stored on the shelf, the sealed samples generally had lower average counts than the unsealed samples.

Samples stored on the shelf had higher average counts compared to their

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counterparts stored in water and in the refrigerator; and except for the pasteurized milk, storage in the refrigerator resulted in the lowest counts.

Table 1. Standard Plate Count (Organisms/Ml. milk)
Under Different Storage Conditions.

Storage Condition:		Shelf			Water			Refrigerator		
Storage Period (Hours)		0	24	48	0	24	48	0	24	48
<u>Brand</u>	<u>Treat- ment</u>	'000			'000			'000		
Peak	A	1	177	DG	1	5	DG	1	2	10
	B	1	8	616	1	4	80	1	4	10
Coast	A	1	356	DG	1	498	DG	1	4	6
	B	1	434	DG	1	8	DG	1	6	3
Black & White	A	1	69	DG	1	77	DG	1	4	3
	B	1	7	14	1	2	14	1	3	4
Rainbow	A	2	34	DG	2	142	DG	2	4	46
	B	2	155	DG	2	78	DG	2	18	45
Pasteurized	A	247	C	C	182	C	C	319	545	DG
	B	221	C	C	168	C	C	278	420	563

DG = Dense growth

C = Curdled

A = Unsealed

B = Sealed.

The methylene blue reduction test results in Table 2 show that the average reduction time for the four brands of evaporated milk was greater than $4\frac{1}{2}$ hours,

Table 2. Methylene Blue Reduction Test of Milk Under Different Storage Conditions

Storage Condition:		Shelf			Water			Refrigerator		
Storage Period (hours)		0	24	48	0	24	48	0	24	48
<u>Brand</u>	<u>Treatment</u>									
Peak	A	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{1}{2}$	$4\frac{1}{2}$	4	2	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
	B	$4\frac{1}{2}$	$3\frac{1}{2}$	2	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
Coast	A	$4\frac{1}{2}$	3	1	$4\frac{1}{2}$	4	$1\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
	B	$4\frac{1}{2}$	3	2	$4\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
Black & White	A	$4\frac{1}{2}$	4	$\frac{1}{2}$	$4\frac{1}{2}$	3	2	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
	B	$4\frac{1}{2}$	$4\frac{1}{2}$	2	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
Rainbow	A	$4\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{1}{2}$	1	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
	B	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{2}$	1	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
Pasteurized	A	4	C	C	4	C	C	4	3	3
	B	4	C	C	4	C	C	4	$3\frac{1}{2}$	3

$4\frac{1}{2}$ = No reduction after $4\frac{1}{2}$ hours. (Grade of milk = Good)

$2\frac{1}{2}$ - $4\frac{1}{2}$ = Reduction between $2\frac{1}{2}$ to $4\frac{1}{2}$ hours (Grade of milk = average)

Less than $2\frac{1}{2}$ = Reduction under $2\frac{1}{2}$ hours (Grade of milk = poor)

A = Unsealed. B = Sealed. C = Curdled.

Table 3. Resazurin Test of Milk Under Different Storage Conditions.

Storage Condition		Shelf			Water			Refrigerator		
Storage Period (hours)		0	24	48	0	24	48	0	24	48
Brand	Treatment									
Peak	A	4	2	0	4	3	0	4	4	4
	B	4	3	2	4	4	3	4	4	3
Coast	A	4	2	0	4	3	0	4	4	3
	B	4	2	0	4	3	0	4	4	3
Black & White	A	4	3	0	4	2	0	4	4	3
	B	4	4	2	4	4	3	4	4	3
Rainbow	A	4	3	0	4	2	0	4	4	3
	B	4	4	2	4	4	3	4	4	3
Pasteurized	A	6	C	C	6	C	C	6	6	5
	B	6	C	C	6	C	C	6	6	5

5-6 = Milk of good keeping quality

3-4 = Milk of average keeping quality

0-2 = Milk of poor keeping quality.

A = Unsealed.

B = Sealed.

C = Curdled.

The percentage protein in the 'Peak' and 'Coast' samples were lower than those of the other two brands at the onset (0 hour) as shown in Table 4a. At 24 hours, there were slight decreases in the protein content of most of the samples. At 48 hours, the percentage protein for the 'Coast' and 'Black & White' samples

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Storage Condition		Shelf			Water			Refrigerator		
Storage Period (hours)		0	24	48	0	24	48	0	24	48
<u>Brand</u>	<u>Treatment</u>									
Peak	A	4	2	0	4	3	0	4	4	4
	B	4	3	2	4	4	3	4	4	3
Coast	A	4	2	0	4	3	0	4	4	3
	B	4	2	0	4	3	0	4	4	3
Black & White	A	4	3	0	4	2	0	4	4	3
	B	4	4	2	4	4	3	4	4	3
Rainbow	A	4	3	0	4	2	0	4	4	3
	B	4	4	2	4	4	3	4	4	3
Pasteurized	A	6	C	C	6	C	C	6	6	5
	B	6	C	C	6	C	C	6	6	5

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Table 4a. Percentage Protein of Milk Under Different Storage Conditions

Storage Condition:		Shelf			Water			Refrigerator		
Storage Periods (hours)	Brand	0	24	48	0	24	48	0	24	48
	<u>Treatment</u>									
Peak	A	8.34	8.44	8.40	8.36	8.33	8.52	8.36	8.46	8.43
	B	8.39	8.35	8.44	8.52	8.41	8.46	8.44	8.36	8.53
Coast	A	8.52	8.55	8.23	8.51	8.08	8.16	8.52	8.52	8.16
	B	8.52	8.52	8.26	8.51	8.49	8.18	8.56	8.56	8.23
Black & White	A	8.87	8.77	8.40	8.86	8.66	8.58	8.86	8.84	8.64
	B	8.84	8.80	8.69	8.86	8.67	8.60	8.86	8.83	8.55
Rainbow	A	8.94	8.92	8.86	8.94	8.90	8.88	8.94	8.92	8.90
	B	8.94	8.90	8.81	8.94	8.91	8.91	8.94	8.91	8.91
Pasteurized	A	2.75	C	C	2.76	C	-	2.75	2.75	2.75
		2.75	C	C	2.77	C	-	2.75	2.76	2.79

A = Unsealed.

B = Sealed.

C = Curdled.

showed some noticeable decreases under all the storage conditions, whilst those for the 'Peak' and 'Rainbow' brands were very minimal.

For the pasteurized milk, the percentage protein was fairly low and showed very little variation, especially when stored in the refrigerator for 24 and 48 hours.

In general, there was very little variation in percentage protein arising either from storage conditions or from sealing or non-sealing of the samples.

The percentage fat content of the evaporated milk samples remained constant at 9% under the different conditions of storage, sealed or unsealed and throughout the entire period of storage (Table 4b). For the pasteurized milk samples, there

Table 4b. Percentage Fat of Milk under Different Storage Conditions.

* Percentage fat for all samples under different storage conditions and periods remained at 9.0% except for pasteurized milk for which the following results were obtained.

Storage Condition.		Shelf			Water			Refrigerator		
		0	24	48	0	24	48	0	24	48
<u>Brand</u>	<u>Treatment</u>									
Pasteurized	A	3.20	C	C	3.20	C	C	3.20	3.14	2.95
	B	3.20	C	C	3.20	C	C	3.20	3.20	2.97

were some very slight variations in milk fat percentage at 24 and 48 hours of storage in the refrigerator.

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DISCUSSION

The results of this study have shown that the storage procedures used for storing partly used processed milk in many Nigerian homes affect to varying degrees, the keeping quality and to some extent, the major chemical constituents.

Although evaporated milk should, by virtue of its processing, be sterile, the results obtained in this study revealed the presence of some bacteria when samples are cultured immediately following the opening of the tins. It is quite possible that this may have resulted from bacterial development in the tins prior to opening, in view of the environmental conditions in which the milk tins are usually kept both before and during sale in the market. It is also conceivable that some of the organisms may have arisen from contamination during plating. However, in view of the very low counts recorded, the evaporated milk samples can be regarded as almost sterile.

On the other hand, the acceptable viable count for pasteurized milk should at no time exceed 30,000 organisms/ml milk (APHA, 1953). The rather high counts recorded for the pasteurized milk samples in this exercise may be regarded as indicating either improper pasteurization or post-pasteurization contamination arising possibly from the cartons used in packaging the milk. Koripamo (1970) suggested that contamination from the cartons may have been responsible for the

high counts recorded for pasteurized milk samples from another dairy in Ibadan. The cartons used at the Iwo Road Dairy were not stored in a way that could have ensured complete sterilization.

The rapid deterioration of the pasteurized milk samples, as evidenced by the curdling at 24 hours of storage on the shelf and in water, underlines the inadequacy of the heat treatment procedure to ensure good keeping of the product under local storage conditions. This tends to confirm the need for the urban dairies marketing pasteurized fresh milk, to continue to seek patronage among the urban dwellers who can afford refrigeration as a means of prolonging the shelf life of the product.

The higher viable counts recorded for the samples stored on the shelf and in water as compared to those in the refrigerator, may have been due to contamination from the surrounding environment, especially as the counts were higher for the unsealed samples. It is also possible that the room temperatures during the experimental period (ranging between 23 to 30°C) encouraged the proliferation of many of the species present.

The comparatively lower counts for the samples stored in the refrigerator would seem to suggest that the temperature range in the food compartment of the domestic refrigerator was adequate in inhibiting the normal growth of the organisms present in processed milk samples used in this study.

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The lower counts for the sealed as compared to the unsealed samples would seem to indicate that there is some merit in the practice of sealing the milk tins after opening and usage as is commonly practised by Nigerians.

The reduction time for the methylene blue dye decreased with increase in the length of the storage period for those samples on the shelf and in water, whilst it was almost constant for the samples in the refrigerator. Although Chalmers (1938) reported that the reduction time for the methylene blue dye decreased with the age of the milk samples, the evidence from this study suggests that the conditions of storage and to some extent, the fluctuations in storage temperatures influenced the reduction time.

The results of the methylene blue dye test have also confirmed the fact that agreement between reduction time and viable counts is greatest with high count milk as has been reported by Johns (1962). The maximum amount of variation in keeping quality accounted for by the methylene blue test recorded in this study is in agreement with the findings of Marutinsam and Singh (1968).

Although the resazurin test is normally applied to raw and pasteurized milk, it was used in the present exercise for evaporated milk samples mainly to serve as a rough guide in determining the degree of spoilage that occurs under the different conditions of storage.

Like the methylene blue dye test results, the resazurin test has shown that the keeping quality of the milk samples decreased with the length of storage. However, where the methylene blue test failed to detect changes in the milk samples stored in the refrigerator for different periods, the resazurin test revealed the small differences in keeping quality that occurred with time.

The small variations in protein content as between brands and storage treatments may have resulted either from the metabolic activities of the bacteria present in the milk or from errors in the methods used in estimating the protein content of the samples.

The absence of any changes in the percentage fat content of milk is not expected, as fat is the last major constituent of milk to be used as food substrate by the microflora of milk. Seaman (1963) reported that fat is not usually destroyed until the slower growing fungi have replaced the bacteria, by which time there would be very little to identify the original medium as milk.

Taken together, the results of the protein and fat analysis indicate that no serious adverse effects can be expected with respect to the nutritional value of processed milk from the storage practices used in Nigerian homes.

In conclusion, although storage in the refrigerator has resulted in the best keeping quality milk, it is recognised that facilities for refrigeration are, at the present time, not within the reach of many Nigerians. In consequence, it could be recommended that storage in a bowl of water with the milk sealed should be adopted

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in homes where there are no facilities for refrigeration. Such storage should however, not be for longer than 24 hours.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the University of Ibadan's Senate Research Grants Committee for funding this study, and to the staff of the Ministry of Agriculture, Iwo Road dairy, Messrs G. A. Paulissen and A. K. Ajayi of the Faculty of Agriculture, University of Ibadan, for their co-operation and assistance.

REFERENCES

- APHA, 1953. American Public Health Association. Standard methods for the examination of dairy products. 10th Ed. Washington D. C.
- A. O. A. C. , 1970. Official methods of analysis of the Association of Official Analytical Chemists. 11th Ed. Washington D. C.
- CHALMERS, C. H. , 1938. The methylene reduction test and the keeping quality of milk. J. Dairy Res. 9, (3) 351-355.
- JOHNS, C. K. , 1962. Milk Hygiene. Hygiene in milk production, processing and distribution. WHO Monograph Series. No. 48, Geneva.
- KORIPAMO, T. A. , 1970. The microflora and keeping quality of milk from the University dairy farm and of the raw and pasteurized milk at Moor Plantation. B. Sc. Project Report, University of Ibadan.
- MARUTINAM, B. and SINGH, P. , 1968. Studies in bacteriological quality of milk. Indian J. Dairy Sci. 21(2), 103-111.
- SEAMAN, A. , 1963. Bacteriology for Dairy Students. Cleaver-Hume Press Ltd. London.

