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The Effect of Storage Period on the Chemical Composition and Coliform Microflora of Wara Cheese*

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Abstract: A study was conducted to evaluate the effect of storage period on the chemical composition and coliform microflora of Wara cheese. Collections were in four batches and each batch served as a replicate of the experiment. Samples were kept in whey and subsequent chemical and microbiological analysis were carried out at the 15th, 39th, 63rd and 87th h of storage at room temperature. Result showed that fresh Wara cheese contained 70.75% moisture, 39.00% fat, 37.08% protein, 2.53% ash, 29.25% total solids while pH and coliform bacterial count (cbc) were 4.85 and 472.75×10^5 cfu g⁻¹, respectively. Total solids, ash and coliform bacteria contents of Wara cheese were significantly ($p < 0.05$) affected by storage period. However, the effects of storage period on fat, protein and pH were negligible. Total solids content and cbc decreased by 5.25 and 95.68%, respectively during storage. A significant correlation was observed to exist between the pH and the % fat ($r = -0.55$; $p < 0.05$) and the % ash contents ($r = 0.60$; $p < 0.05$) of Wara cheese respectively, while a significant though negative correlation ($r = -0.60$; $p < 0.05$) exists between cbc and the % moisture content. It could be concluded that Wara cheese can be stored in whey at room temperature without adverse effect on the nutritive value and consumer health.

Key words: Wara cheese, storage, chemical composition, coliform, pH

Introduction

In the production of the Nigerian soft cheese Wara, the curd contains virtually all the fat, three-quarters of the total proteins, traces of lactose and two-thirds of the calcium of the whole milk. The quality of milk used, in particular its microflora, coupled with lack of standardized processing methods are contributing factors to high variations observed in cheese physico-chemical characteristics (Tzanetakis *et al.*, 1987). In the traditional method of soft cheese manufacture, the amount of vegetable juice (leaf extract) or rennet required for a given quantity of milk is not known. Thus the finished product lacks consistency in quality characteristics compared with conventional processes (Turkoglu *et al.*, 2003). There is therefore the need to increase knowledge on the mechanism governing the quality of the final product to develop production processes yielding consistent results (Belewu, 2001). The most dramatic change which occur in soft cheese after manufacture is the disappearance of lactose which especially with sour Wara cheese is reduced from 4.6 to 0.2% within a period of 12 h after manufacture (Ogundiwin and Oke, 1983). The conversion of carbohydrate into lactate by lactic acid bacteria may be considered the most significant event in food technology (Troller and Stinson 1981; Reys *et al.*, 2005). In addition, classic methods of monitoring cheese ripening have

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involved the assessment of glycolysis (Murmor *et al.*, 1994), proteolysis (Tieleman and Warthesan, 1991) and lipolysis (Park, 2001). These complex reactions are responsible for texture changes and the perception of the characteristic aroma of cheese (Kuo and Gunasekaran, 2003).

Various studies have shown the extent to which handling after manufacture influenced the quality of cheese (Massa-Calpe, 1996). However, poor hygiene and greater susceptibility of the cheese to bacterial growth explains the higher level of contamination in fresh cheese (Turkoglu *et al.*, 2003). For most cheeses, the maximum coliform counts were found in the curd, whilst minimum values occurred at the storage periods (Gomez *et al.*, 1989).

Wara cheese is a variety that is consumed fresh. However, locally, Wara cheese is fried to extend its shelf life and added as support or substitute to meat in diets as a source of animal protein. Since the current under-production of animal protein in developing countries is caused by lack of storage. There is therefore the need to evaluate the changes in the chemical composition and the coliform bacterial population of Wara during storage. This study was therefore carried out to evaluate the effect of storage period on the chemical composition and coliform bacterial count of Wara.

Materials and Methods

Studies on the effect of storage period on the chemical composition, pH and the coliform bacteria population of Wara cheese were carried out during the dry season (Jan/Feb) in the Microbiology laboratory of the Department of Animal Science, University of Ibadan, Nigeria. Soft cheese samples used in this study were purchased from local sellers in Ibadan, Nigeria. Collections were in four batches and each batch served as a replicate of the experiment. Samples were kept in whey at room temperature and subsequent chemical and microbiological analysis carried out at the 15th, 39th, 63rd and 87th h of storage treatment.

Appropriate dilutions of homogenized samples (11 g in 99 mL of sterile distilled water) were incubated in Violet Red Bile Agar (VRBA) (Oxoid) for coliform bacterial counts. pH was measured directly on a Metrohm-Herisau (Metrohm Ltd., Herisau, Switzerland) pH meter. Fat was analyzed by the standard Gerber method, while protein was determined by the micro Kjeldahl method. Moisture and ash contents were determined by standard methods (AOAC, 1980). Results were statistically evaluated by analysis of variance (Steel and Torrie, 1980) while differences among means were detected using Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Fresh Wara cheese contained 70.75% moisture, 39.00% fat, 37.08% protein and 2.53% ash while pH and cbc were 4.85 and 472.75×10^5 cfu g⁻¹ (Table 1). These results except for %ash content, which was lower, falls within the range of previous findings (Fashakin and Unokiwedi, 1992; Oguniwin and Oke, 1983; Belewu, 2001). Absence of standard processing methods explains the variations observed in the nutrient composition of cheese in developing countries (Turkoglu *et al.*, 2003; Belewu, 2001). The effect of storage period on the moisture content was significant ($p < 0.01$). The average moisture content on days 0, 1, 2 and 3 were 70.75, 71.50, 81.75 and 76.00%, respectively and averaged 75.00% for the whole storage period. As the pH of curd and whey decreases prior to draining, more calcium is transferred from the curd into the whey. Generally, this transfer has been reported to effect an increase in cheese moisture content resulting in softer cheese. Contrariwise, the effects of storage period on the % fat and % protein contents were negligible. However, a consistent increase in the

Table 1: Effect of storage period on the chemical composition and coliform count of Wara cheese

Storage period (days)	Moisture (%)	Total solids (%)	Fat (%)	Protein (%)	Ash (%)	pH	CBC *10 ⁵ (cfu g ⁻¹)
0	70.75±0.48 ^c	29.25±0.48 ^a	39.00±2.71	37.08±1.71	2.53±0.19 ^a	4.85±0.56	472.75±59.20 ^a
1	71.50±1.50 ^c	28.50±1.50 ^a	39.20±2.01	36.96±2.94	2.73±0.23 ^a	4.50±0.81	80.50±39.43 ^b
2	81.75±1.49 ^a	18.25±1.49 ^b	39.80±0.96	37.64±2.21	2.99±0.17 ^b	4.34±0.70	22.00±21.33 ^b
3	76.00±1.22 ^b	24.00±1.22 ^c	38.73±3.14	41.10±1.03	2.67±0.10 ^a	4.33±0.70	21.00±21.00 ^b
Av.	75.00±1.26	25.00±1.26	39.18±1.18	38.20±1.05	2.83±0.09	4.50±0.35	149.06±19.29

abc: Means in the same column differently superscripted differ significantly (p<0.05)

Table 2: Correlation analysis of parameters observed during storage

	pH	CBC	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Total solids (%)
pH		0.40	0.40	-0.55*	0.23	0.60*	0.18
CBC			-0.60*	-0.19	-0.12	0.31	0.07
Moisture (%)				0.21	0.14	0.03	0.15
Fat (%)					-0.42	-0.46	0.21
Protein (%)						0.34	0.29
Ash (%)							0.16

*: p<0.05

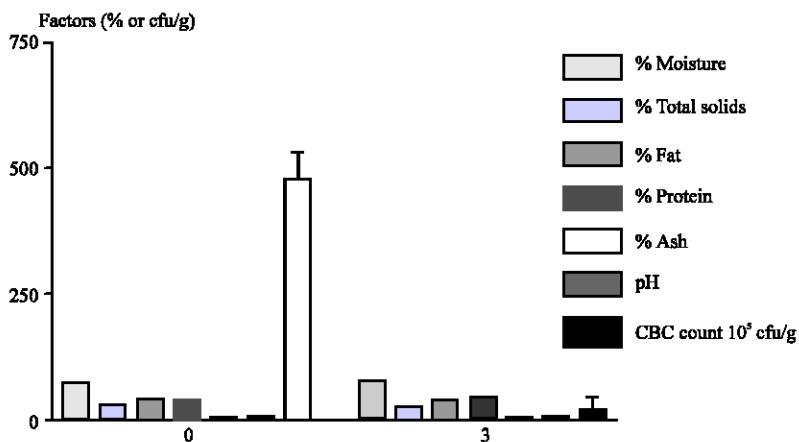


Fig. 1: The effect of storage period on the chemical composition and coliform count of Wara

protein content of Wara cheese was observed during storage. The mean values were 37.08, 36.96, 37.64 and 41.10% on 0, 1, 2 and 3 day of storage. The increase observed in the protein content might probably be partly of bacterial origin, important in this respect is the lactic acid bacteria which have been reported to be the most predominant in fermented milk products by low pH (Gomez *et al.*, 1989). In addition, a progressive increase in the total content of free amino acids has been reported during ripening of Mahon cheese (Garcia-Palmer *et al.*, 1997). Proteolysis in cheese has been shown to directly affect the development of the desired aroma, texture and intensity of background flavour of most mature ripened cheese (Engels and Viser, 1994; Fox, 1989).

Most thermal processing has been found to leave heat-stable lipolytic enzymes almost intact thereby influencing food quality (Deeth and Fitz-Gerald, 1976). In this study, the 0.8% unit increase in %fat content up till the second day of storage was lower than the 1.07% unit decrease between the second and third day of storage. This result parallel previous findings (ABD EL-Salam *et al.*, 1978) in

which storage period had a significantly ($p < 0.01$) positive effect on the fat content of the Egyptian Ras cheese. The % ash contents of Wara cheese were similar during storage except for day 2, which was significantly higher (2.99%). pH tends to decrease with storage period. The increasing acidity in stored Wara cheese would probably increase its shelf life by inhibiting the growth of spoilage and pathogenic microorganisms thus making it safer for human consumption (Fig. 1). A highly significant ($p < 0.01$) correlation ($r = 0.604$) was found between pH and % ash content of Wara (Table 2). In addition, the correlation between pH and the % fat content of Wara cheese was negative ($r = -0.554$; $p < 0.01$). Coliform bacteria count was significantly ($p < 0.01$) affected by storage period. The initial value was significantly higher than the declining values during storage (Table 1). This observation corroborates previous findings in which maximum coliform counts were found in the curd, whilst minimum values occurred at the storage periods (Gomez *et al.*, 1989; Mormur *et al.*, 1994; Gaya *et al.*, 1983). Earlier report also revealed inhibition of *E. coli* from the onset of fermentation and complete elimination after 24 h of storage (Feresu and Inyati, 1990). A significant though negative correlation ($r = -0.60$; $p < 0.05$) was observed between cbc and the % moisture content. However, Turkoglu *et al.*, (2003) in studies with Orgu cheese reported a positive correlation ($r = 0.474$). Apart from acid production by lactic acid bacteria, there is the likelihood that these microorganisms produce different types and quantities of inhibitory products such as antibiotics, volatile acids and hydrogen peroxide during fermentation. This observation therefore suggests that a three-day storage period is probably an effective way of ensuring a minimal content of coliform bacteria in Wara cheese.

Conclusions

From the results of the study, it could be concluded that Wara can be stored in whey at room temperature without adverse effect on the nutritive value and consumer health. However, it is essential that a standardized production process on industrial scale be developed and hygienic quality be improved.

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