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Nutritional and Rheological evaluation of West African Soft cheese made from plant coagulant (*Calotropis procera*) during storage

Belewu M. A.

Ruminant Nutrition and Dairy Science Laboratory Department of Animal production, University of Ilorin, Kwara State, Nigeria

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Abstract

Storage of West African soft cheese "Warankasi" for up to 15 weeks in a refrigerator was examined for the composition, protein fractions (non casein nitrogen, non protein nitrogen, casein nitrogen, total nitrogen) hardness, cohesiveness, gumminess, elasticity, chewiness, adhesiveness and pH. Whereas cheese hardness, gumminess, elasticity, chewiness and adhesiveness decreased as the storage day progressed, the protein fractions (NCN, NPN, CN, and total nitrogen) increased slightly. Each of the textural measurement correlated significantly ($p < 0.05$) with the pH. The correlation coefficient (0.68) indicates that increased total nitrogen content and pH will result in higher cheese hardness, gumminess and adhesiveness. It is then concluded from this study that the quality control system of west African Soft Cheese could be based on the rheological measurement.

Key words: West African soft cheese, casein nitrogen, protein fractions and rheological properties.

Abbrev. NCN - Non Casein nitrogen, CN= casein nitrogen, NPN - Non protein nitrogen

Introduction

There is the need to increase knowledge on the mechanisms governing the quality of the final product to develop production processes yielding consistent results. The rheological measurements are related to the mechanical attributes of texture and the results are vital for those involved in the chain of production, from farmers to consumers (Walstra and Peleg, 1991). There is great interest in defining quality especially for Appellation d'Origine controlée (AOC) Cheeses (Grappin *et al.* 1993). Therefore, production of consistently high quality AOC cheese continues to be a great challenge.

Rheological and nutritional qualities of cheese may vary due to the differences in the composition in milk and maturity of the cheese (Walstra and Vanvliet, 1982; Walstra *et al.*, 1986 and Luyten, 1988). These changes may also be related to the changes in pH, moisture, and salt content. Viser (1981) and Fox and Law (1991) attributed the changes to the proteolysis of the casein protein matrix caused by rennet, indigenous milk proteinases and starter enzymes. The rheological and nutritional changes in cheese analogues are vital in term of the quality, quantity, meltability, shredability and marketing of the product. Until now, scientific information on the rheological and nutritional properties and their relationship are lacking on this locally made cheese and the author is not aware of any published work on the rheology and proteolysis of local cheese in Nigeria.

The experiment reported herein was undertaken to determine the rheological and proteolytic changes in West African soft cheese (Warankasi) made from plant coagulant (*Calotropis procera*) and to investigate the relationship between composition and rheology.

Materials and methods

West African soft cheese (Warankasi) was obtained from the local market in Ilorin, Kwara State, Nigeria. The cheese was placed in the whey to minimize losses of moisture and stored in the refrigerator. Four (4) cheeses were selected at random from different markets, which were also chosen at random. Any cheese effect may be due to the milk composition and system of cheese making. For testing, the cheeses were cut into cubes of 2.54 x 2.54 x 3.28 cm and divided into sub samples which were removed from storage for rheological and composition testing.

Rheological Evaluation

All rheological studies were made in triplicate and the following parameters were monitored; Hardness, chewiness elasticity, cohesiveness (ratio), Gumminess and adhesiveness as prescribed by Chen *et al*, (1979). Hardness is the amount of maximum force that is exerted on the sample. Gumminess is the product of hardness and cohesiveness. Elasticity was the ratio of the sample heights before and after the compression while chewiness was the product of the elasticity and gumminess.

Proteolysis Evaluation

The proteolysis in the cheese was monitored weekly during maturity or ageing while the chemical composition was determined by Butikofer *et al*, (1993). The pH was measured with one part of the cheese and nine parts of distilled water (w/v).

Statistical analysis

All data collected were subjected to a completely randomised design while correlation and regression analyses were also calculated between rheological properties and chemical composition during the storage period.

Results and Discussion

The results of the cheese chemical composition of the cheese used are shown in [Table 1](#) while the effect of storage on the rheological, chemical composition and protein fractions are shown in [Table 2](#).

The accuracy of the primary proteolytic and rheological measurements were estimated in triplicate. The coefficient of variance for hardness, chewiness, elasticity, cohesiveness, gumminess and adhesiveness were 7.0%, 5.8%, 5.6%, 5.70%, 6.60% and 20% respectively. Each of the rheological measurement for the cheese was correlated with the chemical composition and protein fractions and pH by multiple linear regression analysis. In the regression analysis, the rheological measure was the dependent variable while the chemical composition and protein fractions and pH were independent variables. A stepwise regression which indicates the most significant independent variable is shown in [Table 3](#). The results revealed that storage of the cheese had influence on the protein content and higher pH results in higher cheese hardness, gumminess and adhesiveness. When total nitrogen

is selected for correlation with hardness $R=0.62$ and it increased from 0.30 to 0.68 when the effect of other parameters were added ([table 4](#)). The significance of the independent variables on the textural characteristics follows this sequence Casein Nitrogen > fat > pH which shows that protein appears more frequently in the first column and pH in the last column. This was contrary to the reports of Chen *et al.* (1978). Variations in the other sequence may be due probably to the differences in the milk composition and methods of cheese making. This analysis and interpretation helps in detecting the significance of each of the experimental variables as well as providing a method evaluation of multidimensional system (Chen *et al.* 1979). Elasticity, gumminess and chewiness were significantly negative correlated with the age of the cheese (-0.73, -0.86, and -0.92 respectively). The results show that total nitrogen among the various nitrogen fractions had a significant influence on the rheological properties of the locally made cheese (Warankasi) and this could be attributed to the proteolysis of the protein matrix and high production of soluble nitrogen with age. It can then be concluded that rheological tests are needed to evaluate the mechanical textural parameters but not geometrical or surface values. The strong correlation found between the rheological and nutritional qualities support the reason to retain the rheological method since it is more sensitive to the effect of age. The relationship described in this paper suggest that there is an opportunity to base a quality control system of West African Soft Cheese on rheological measurement.

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Table 1. Chemical composition of West African soft cheese (Warankasi)

Parameters	%
Protein	23.10 ± 0.32
Water	45.20 ± 0.59
Fat	15.30 ± 1.10
Ash	4.50 ± 0.15
pH	6.50 ± 0.06

Table 2 effect of storage on the rheological, chemical composition and proteolysis characteristics of West African Soft Cheese (Warankasi)

Weeks	Hardness	Cohesiveness ratio	Gumminess (g)	Plasticity ratio	Chewiness	Adhesiveness	Fat %	Total N mg/g	NCN mg/g	NP N mg/g	Casein N mg/g	pH
0	6.40 ±0.25	0.40 ±0.02	2.98 ±0.05	0.85 ±0.02	2.55 ±0.07	3.10 ±0.08	15.20 ±1.15	30.39 ±5.10	5.00 ±0.40	2.20 ±0.10	25.39 ±3.12	5.10 ±0.26
3	6.15 ±0.25	0.42 ±0.02	2.80 ±0.03	0.87 ±0.02	2.50 ±0.6	3.20 ±0.07	16.50 ±1.20	29.10 ±4.38	6.09 ±0.11	2.38 ±0.13	23.41 ±3.05	5.08 ±0.25
6	5.20 ±0.18	0.50 ±0.06	2.65 ±0.02	0.84 ±0.01	2.45 ±0.05	2.25 ±0.05	15.80 ±1.25	31.50 ±5.11	6.37 ±0.12	2.50 ±0.15	25.13 ±3.50	5.10 ±0.26
9	5.06 ±0.06	0.50 ±0.06	2.58 ±0.02	0.81 ±0.01	2.40 ±0.04	2.23 ±0.03	15.70± 1.20	31.80 ±5.12	6.50 ±0.20	2.55 ±0.18	25.30 ±3.65	5.09 ±0.26
12	4.58 ±0.17	0.53 ±0.07	2.50 ±0.03	0.79 ±0.01	2.39 ±0.03	2.18 ±0.02	15.50 ±1.22	32.00 ±5.11	6.80 ±0.22	2.60 ±0.20	25.20 ±3.10	5.11 ±0.27
15	4.50 ±0.15	0.58 ±0.08	1.99 ±0.03	0.75 ±0.01	2.38 ±0.02	2.15 ±0.02	15.20 ±1.20	32.05 ±5.11	6.90 ±0.25	2.70 ±0.21	25.15 ±3.11	5.06 ±0.25

NPN = Non protein Nitrogen; NCN = Non-Casein Nitrogen; CN = Casein Nitrogen; Total Nitrogen. All of which were determined by the Kjeldahl method.

Table 3: Multiple Linear Regression coefficients of Rheological characteristics on chemical composition proteolysis and pH of West African soft cheese.

	pH	Casein Nitrogen	True nitrogen	Fat
Hardness	0.43	-0.15	0.52	0.38
Cohesiveness	0.35	0.23	0.07	0.42
Gumminess	0.39	0.03	0.51	0.39
Chewiness	0.21	-1.98	-0.08	0.12
adhesiveness	3.42	-0.90	0.80	0.08
Elasticity	0.03	-0.13	0.02	0.02

Table 4. Increase of multiple correlation with addition to stepwise multiple regression of components and pH to predict rheological characteristics of West African Soft Cheese (Warankasi)

Hardness	X ₂ (0.30)	X ₁ (0.62)*	X ₄ (0.63)*	X ₃ (0.68)*
Cohesiveness	X ₂ (0.40)	X ₄ (0.43)	X ₃ (0.58)*	X ₁ (0.89)**
Gumminess	X ₂ (0.30)	X ₄ (0.37)	X ₁ (0.67)*	X ₃ (0.83)**
Chewiness	X ₂ (0.20)	X ₄ (0.40)	X ₁ (0.46)	X ₃ (0.50)
Adhesiveness	X ₁ (0.38)	X ₂ (0.59)*	X ₃ (0.63)*	X ₄ (0.65)*
Elasticity	X ₁ (0.39)	X ₂ (0.45)	X ₄ (0.61)*	X ₃ (0.77)**

X₁ = Total nitrogen; X₂ = Casein nitrogen; X₃ = pH; X₄ = fat; * = Significant at p<0.05; ** = Significant at p<0.01