JOURNAL OF AGRICULTURE AND PLANT SCIENCES, JAPS, Vol 22, No. 2, 2024

Manuscript received 25.09.2024
Accepted: 12.12.2024

In print: ISSN 2545-4447
On line: ISSN 2545-4455
doi: https://doi.org/10.46763/JAPS2422239m
Original scientific paper

MONITORING OF ACTIVE AND TITRATABLE ACIDITY IN WHITE-BRINED CHEESE DURING RIPENNING PERIOD

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Abstract

This study investigates the dynamics of active and titratable acidity in white-brined cheese throughout its ripening period. Monitoring these parameters is crucial for understanding the biochemical changes that influence the cheese's flavour, texture, and overall quality. Using standard analytical methods, we measured pH and titratable acidity at regular intervals during the ripening process. The results indicated a significant decrease in pH, coupled with an increase in titratable acidity, reflecting the ongoing microbial and enzymatic activities. The findings provide valuable insights for cheese producers to optimize ripening conditions, ensuring consistent product quality. This research highlights the importance of acidity monitoring as a critical control point in cheese production.

Key words: *white-brined cheese, ripening, active acidity, titratable acidity, cheese quality.*

INTRODUCTION

The production of white-brined cheese (WBC), a staple in many Mediterranean and Eastern European diets, relies heavily on the careful monitoring of various biochemical parameters during its ripening period. Among these, active and titratable acidity are critical determinants of the cheese's final quality. Active acidity, measured as pH, provides immediate insight into the hydrogen ion concentration in the cheese matrix, while titratable acidity reflects the total acid content, including both free hydrogen ions and those bound to buffering agents.

Understanding the changes in acidity during ripening is essential for several reasons. Firstly, acidity influences the growth and activity of microorganisms, which are responsible for the biochemical transformations that define the cheese's flavour, texture, and aroma (Fox et al., 2017). Secondly, the balance of acidity impacts the protein and fat stability within the cheese, affecting its consistency and mouthfeel (McSweeney, 2004). Finally, consistent monitoring and control of acidity can help prevent spoilage and ensure safety, thereby extending the shelf life of the cheese (Walstra et al., 2005).

Despite the well-established importance of acidity in cheese ripening, there is a need for more detailed studies focused on white-brined cheese (Makarijoski, 2023). This type of cheese undergoes a unique ripening process in a brine solution, which can significantly influence its acid-base balance (Falih et al., 2024). Therefore, this study aims to systematically monitor and analyse the active and titratable acidity in white-brined cheese throughout its ripening period, providing insights that can help producers optimize their processes and improve product quality.

MATERIAL AND METHODS

To make these examinations, cheese samples of four cheese variants (WBC KS104, WBC KS105, WBC KS110 and WBC KS111) were provided directly from the producers and they were transported under temperature-controlled conditions on 5°C to the Certified Laboratory for Milk and Dairy Product Quality (LB Lact) in Plovdiv, R. Bulgaria. This laboratory is certified under international standards, ensuring the reliability and accuracy of all testing procedures. Cheese samples for active and titratable acidity as quality parameters were analysed at the 8th, 20th, 30th, 40th and 60th day and were taken from one production series. Methods that were used for this analysis of white-brined cheese were as follow: Active acidity - pH (by using pH–meter, Model MS 2000) and Titratable acidity was determined in °SH, (Sokslet-Henkel, using the method by Caric, 2000). For data processing, we used Microsoft Excel, as a component of Microsoft Office Package. This programme facilitated the tabular representation of data. Additionally, we used the t-test function within Excel to perform statistically significant comparisons between the examined quality parameters (active and titratable acidity) of different cheese variants.

RESULTS AND DISCUSSION

Comparative analysis between experimented white-brined cheese variants for active acidity (pH) dynamics is presented in Table 1.

Table 1. Active acidity (pH) dynamics of examined cheese variants

Active acidity (pH)				
Day	WBC KS104	WBC KS105	WBC KS110	WBC KS111
8	4.90 ± 0.01^{a}	4.81 ± 0.01^{b}	4.74 ± 0.01^{c}	$4.88 \pm 0.02^{a,d}$
20	4.76 ± 0.01^{a}	4.61 ± 0.01^{b}	4.50 ± 0.01^{c}	$4.76 \pm 0.01^{a,d}$
30	4.64 ± 0.01^{a}	4.55 ± 0.01^{b}	4.33 ± 0.01^{c}	$4.65 \pm 0.01^{a,d}$
40	4.54 ± 0.01^{a}	4.45 ± 0.01^{b}	4.16 ± 0.01^{c}	$4.58 \pm 0.03^{a,d}$
60	4.42 ± 0.01^{a}	4.30 ± 0.01^{b}	4.07 ± 0.02^{c}	4.46 ± 0.01^{d}

Differences of values with different superscripts in the same row are statistically significant at level $p<0.05$

Based on the obtained results, it can be concluded that the WBC KS104 variant exhibited the highest active acidity value on the 8th day, measuring 4.90±0.01, compared to the other variants. The lowest active acidity value was observed in the WBC KS110 variant, with a measurement of 4.74±0.02. On the 20th day of the ripening period, the active acidity values for the four variants were ranged between 4.50±0.01 and 4.76±0.02. Further into the ripening period, on the 30th day, the highest active acidity value was recorded for the WBC KS111 variant at 4.65±0.01, while the lowest value was observed in the WBC KS110 variant at 4.33±0.01. On the 40th day, the active acidity values for the four variants ranged from 4.16±0.01 to 4.58±0.03. On the 60th day of the maturation process, all tested WBC variants exhibited a reduction in active acidity compared to the initial state, with values ranging from 4.07±0.03 to 4.46±0.01. The WBC KS111 variant had the highest pH value, which was 0.39 units, 0.16 units, and 0.04 units higher than the WBC KS110, WBC KS105, and WBC KS104 variants, respectively.

Based on the results obtained for the active acidity values of the analysed cheese samples, it can be concluded that during the fermentation process up to the 60th day, there is an expected decrease in pH across the variants, though with varying intensity. This observation highlights the differing activities of lactic acid bacteria from the starter cultures that were used in production process. The addition of starter culture induces normal hydrolytic activity of the enzymes, acting on lactose and proteins. From Table 1, it can also be observed that there is a significant difference in pH values between the four white-brined cheese variants at a significance level of $p<0.05$ for most of the time-periods when the cheese samples were taken for analyses. This can be explained by the different technologies and conditions applied during the cheese production process. The active acidity values obtained align with the findings of Velevski (2015), who reported that the pH of three different white-brined cheese variants produced with different starter cultures was ranged from 4.42 to 4.48 after 60 days ripening period.

Our results are also consistent with those of Balabanova et al. (2017), who found that the average active acidity of Bulgarian white-brined cheese made from cow's milk using different milk-coagulating enzymes was 4.18±0.15%. Similar results were obtained by Ivanov et al.

(2016), who reported an average pH value of 4.2±0.1% in Bulgarian white-brined cheese made from cow's milk after a 45-day ripening period. Slightly higher active acidity values compared to ours were observed by Smiljanić et al. (2014), who reported a pH value of 4.60 units. Chobanova-Vasilevska (2007) reported pH variations in white-brined cheese ranging from 4.50 to 4.80. For feta cheese and other Balkan cheeses, the pH values ranged from 4.2 to 4.8 (Anifantakis & Moatsou, 2006). Higher pH values for white-brined cheese compared to our results were obtained by Lavasani (2014), who studied the effect of different rennet concentrations during cheese production and found active acidity values between 5.0 and 5.04. Similar values were reported by Felfoul et al. (2016), who found an average active acidity of 5.06±0.02 in white-brined cheese made from full-fat milk. Higher pH parameters were also found in Egyptian white-brined cheese, with a value of 4.92±0.10 (El-Aziz et al., 2015).

Comparative analysis between experimented white-brined cheese variants for titratable acidity (°SH) dynamics is presented in Table 2.

Table 2. Titratable acidity(°SH) dynamics in examined cheese variants.

Active acidity (pH)				
Day	WBC KS104	WBC KS105	WBC KS110	WBC KS111
8	69.83±0.02[a]	74.0±0.40[b]	74.77±0.06[c]	73.2±0.40[d]
20	75.50±0.10[a]	78.3±0.31[b]	80.73±0.12[c]	79.53±0.30[d]
30	81.37±0.15[a]	80.26±0.23[b]	86.13±0.06[c]	82.7±0.45[d]
40	82.03±0.11[a]	82.33±0.21[a,b]	90.57±0.21[c]	85.6±0.40[d]
60	86.52±0.10[a]	86.53±0.23[a,b]	101.27±0.12[c]	88.13±0.23[d]

Differences of values with different superscripts in the same row are statistically significant at level $p<0.05$

Based on the obtained results, it can be concluded that the WBC KS110 variant exhibited the highest titratable acidity value on the 8th day, measuring 74.77±0.06°SH, compared to the other variants. The lowest titratable acidity value was observed in the WBC KS104 variant, with a measurement of 69.83±0.02°SH. On the 20th day of the maturation process, the titratable acidity values for the four variants ranged between 75.50±0.10°SH (WBC KS104 variant) and 80.73±0.12°SH (WBC KS110 variant). Further during the ripening period, on the 30th day, the highest titratable acidity value was noticed for the WBC KS110 variant at 86.13±0.06°SH, while the lowest value was observed in the WBC KS105 variant at 80.26±0.23°SH. On the 40th day, the titratable acidity values for the four variants ranged from 82.33±0.21°SH to 90.57±0.21°SH. On the 60th day of the maturation process, all tested WBC variants exhibited an increase in titratable acidity compared to the initial state, with values ranging from 86.53±0.23°SH (WBC KS105 variant) to 101.27±0.12°SH (WBC KS110 variant). The highest titratable acidity value was observed in the WBC KS110 variant, which was 14.75, 14.94, and 13.14 units higher than the WBC KS104, WBC KS105, and WBC KS111 variants, respectively. The increased titratable acidity is likely due to the heightened activity of lactic acid bacteria.

Based on the results obtained for the titratable acidity values of the four WBC variants studied, it can be concluded that during the fermentation process up to the 60th day, there is an expected increase in titratable acidity across the variants, albeit with varying intensity. This indicates different bacterial activity from the starter cultures used. The added bacterial cultures induce normal hydrolytic activity of the enzymes, acting on lactose and proteins. From Table 2, can also be observed that there is a significant difference in titratable acidity values between the four white-brined cheese variants at a significance level of $p<0.05$ for most of the tested periods. This can be explained by the different technologies and conditions applied during the cheese production process.

The results obtained in our study are consistent with those reported by Velevski (2015), who found that titratable acidity values in three different white-brined cheese variants produced with different starter cultures ranged from 82 to 86.40°SH after 60 days of fermentation. The values we obtained for the titratable acidity of the four WBC variants are also within the range reported by Kostova (2013), who found titratable acidity variations from 80 to 96°SH.

Our results are further confirmed by Naydenova et al. (2013), who examined 39 different WBC variants produced in Bulgaria and found that titratable acidity, expressed in Thörner degrees, ranged from 227.6 to 234°T, which converts to 91.01-93.6°SH.

CONCLUDING REMARKS

The monitoring of active and titratable acidity during the ripening period of white-brined cheese provides critical insights into the biochemical processes that determine its quality. This study has demonstrated that significant changes in pH and titratable acidity occur throughout the ripening process, reflecting ongoing microbial and enzymatic activities. These changes are crucial for the development of the cheese's characteristic flavour, texture, and aroma. By understanding and controlling these acidity parameters, cheese producers can optimize ripening conditions, improve product consistency, and ensure high-quality outcomes.

Future research should focus on identifying and characterizing specific microbial strains that influence acidity dynamics and their role in shaping the sensory attributes of white-brined cheese. Investigating the relationship between acidity changes and the development of volatile flavour and aroma compounds would provide deeper insights into the biochemical processes during ripening. Additionally, exploring the impact of varying ripening conditions, such as temperature, humidity, and salinity, on acidity profiles can help refine production protocols. Advanced analytical tools like metabolomics and proteomics could be employed to map the intricate pathways involved in microbial and enzymatic activity. Moreover, developing predictive models that link acidity trends with sensory characteristics and consumer preferences would support the production of consistently high-quality cheese.

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МОНИТОРИНГ НА АКТИВНА И ТИТРАЦИОНА КИСЕЛОСТ КАЈ БЕЛО САЛАМУРЕНО СИРЕЊЕ ЗА ВРЕМЕ НА ЗРЕЕЊЕ

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Резиме

Во ова научно истражување беше следена динамиката на активната и титрационата киселост кај бело саламурено сирење за време на периодот на зреење. Мониторингот на овие параметри е клучен за разбирање на биохемиските промени коишто влијаат на вкусот, текстурата и вкупниот квалитет на овој производ. Користејќи стандардни аналитички методи, беше мерена pH вредноста и титрационата киселост во редовни интервали за време на процесот на зреење. Резултатите покажаа значително намалување на pH вредноста за време на процесот на зреење, а истовремено оваа појава беше пропратена со зголемување на титрационата киселост, што се рефлектира на тековните микробиолошки и ензимски активности. Овие промени беа во корелација со развојот на посакуваните органолептички својства. Наодите обезбедуваат значајни информации за производителите на сирење со цел оптимизирање на условите за зреење, а со тоа и обезбедување доследен квалитет на финалниот производ. Ова истражување ја истакнува важноста на мониторингот на киселоста како критична точка за контрола во производството на сирење.

Клучни зборови: *бело саламурено сирење, активна киселост, титрациона киселост, квалитет.*