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PRODUCTION, COMPOSITION AND CHARACTERISTICS OF ORGANIC HARD CHEESE

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Abstract: Organic cheeses are value added products that provide small dairy farmers with a viable source of income and has the potential to revitalize farms, provide new jobs, and develop new cheese varieties with unique flavours for consumers to experience. Production of hard organic cheese must comply with organic standards and regulations of organic production. Whole organic milk that does not contain residues of pesticides, hormones and antibiotics represents a quality raw material for hard organic cheese with added value. Together with the existing, producers develop and create new technologies and new branded products which are more original and recognizable. The goal of any technology is obtaining technologically reproducible protocol and constant uniform quality of the cheese with desired properties. In this paper some variables which influence quality of organic hard cheese were investigated. Tested samples of hard organic cheese from different production time showed consistent quality and obtained parameters followed the standards of full-fat hard cheeses.

Key words: the organic production, hard-type cheese, technology, quality

Introduction

Organic farming is an agricultural system which is identified as production of a high value where standards and methods of organic production should enable producers to get certified to produce high quality and safety product.

Organic cheeses should be recognized on the market and represent the best part of organic production. The demand for organically produced cheese is increasing and if we want this to continue than organic cheeses should meet the quality that justifies an additional price in relation to the conventionally produced

cheese (*Nielsen et al., 2001).* Consumers showed a willingness to pay organic cheese despite its higher price. The information about organic farming could be a major determinant of cheese liking and consumer willingness to pay, thus providing a potential tool for product differentiation, particularly for small scale and traditional farms (*Napolitano and Braghieri, 2010).*

Cheese is the most complex of the dairy products, involving chemical, biochemical and microbiological processes. Hard cheeses represent a large group of cheese that has a distinctive taste and smell (a pleasant, sharp, spicy, never mild), color of dough is golden-yellow, firm texture and plastic, with (2-6 mm) or without holes (*Popović-Vranješ, 2015*). Both artisanal and mass production cheese making methods use the same basic steps. The manufacturing different cheeses does not require widely various procedures but rather the same steps with variations during each step, special applications, or different ripening practices. Organic cheese is produced following the same manufacture methods as with conventionally cheese, the only differences are in some substances, which are not allowed in organic cheeses. Codex Alimentarius Commission in the regulations for organic products allows microorganisms and enzymes derived from microorganisms that are normally used in food production, except genetically obtained/modified microorganisms or enzymes originating from genetic engineering. Also, some additives used in conventional production as colorants, flavor enhancers or preservatives are not allowed (*CODEX, 1999).*

The manufacturing process plays a crucial role, especially with artisan cheeses, like raw, PDO and regional type traditional cheeses, because cheese making methods affect the composition of the original milk differently (*Lucey and Fox, 1993).* For raw milk cheese, milk production is the first critical control point (CCP) in the cheese maker's Hazard Analysis and Critical Control Point (HACCP) plan (*Marler, 2009).* In the research done by *Coppa et al., (2011)* the cheese making technology seemed to be critical, but also the microbiological and chemical composition of the milk. The quality of cheese is influenced by many aspects of milk quality: milk composition, microbiology, somatic cell count (SCC), enzymatic activity, and chemical residues (*Law and Tamime, 2010*). Pasteurization destroys most useful microorganisms, inactivates the enzymes and destroys some substances that are specific for organic milk. Cheeses obtained from raw milk have more complex aroma and taste.

Organic cheese minimizes exposure to the toxins and pesticides often associated with conventional farming practices. For many people this is an important consideration for buying organic milk and cheese. There are different feeding strategies and feeds like pasture, conserved forages (hay, silages, etc.) and concentrates which are used in animal diets influence on the quality of milk and cheese (*Tsiplakou et al., 2010).* Organic cows are fed large amount of silages, especially in winter. Between organic samples is also possible to distinguish cheeses obtained from milk produced in different months. Cheeses obtained in

spring and summer seasons (from April to August) are clearly set apart from those produced during winter months and this latter are similar to cheeses produced in conventional dairy (*Miotello, 2010*).

There are many ways to evaluate the quality of the cheese. Cheese quality may be defined as the degree of acceptability of the product to the consumer (*Peri, 2006)*. Quality criteria involve different characteristics, including: sensory (taste, aroma, texture, appearance), physical (sliceability, crumbliness, hardness, mouth-feel), cooking (extent of flow, stringiness), chemical (intact casein, free fatty acids, free amino acids), compositional/nutritional (protein, fat, calcium, lactose, sodium content), and safety (absence of pathogens, toxic residues, foreign material) (*Law and Tamime, 2010*).

The aim of the study was to determine the effect of organic standards and methods on the organic hard cheese production. In addition, this paper describe technology, analysed the chemical composition and some parameters of organic cheese ripening.

Material and methods

Eight samples of cheeses were taken from organic producer and analysed during the three months of production. Analysis of cheese samples was conducted at the Laboratory for quality control of feed and animal products, Department of Animal Science, Faculty of Agriculture, Novi Sad, Serbia.

Chemical and compositional analyses (titratable acidity, total solids, moisture, fat, protein, salt) of cheese samples were determined after 3 month of ripening. Total protein was determined by measuring total nitrogen in the cheeses using the Kjeldahl method. Dry matter was measured by drying the sample to a constant weight. Fat content was determined according to Gerber, and titratable acidity according to Soxlet-Henkel method. Salt analyses were run using ion selective electrode.

Basic steps in cheese making include milk acidification and coagulation, whey draining, heating and salting the cheese curd and ripening (Table 1). Even slight changes in these processes can lead to significant differences in the final cheese composition and properties. Control of these steps is crucial in the cheese making transformation and the changing raw material (milk) into different cheese types. The cheese making techniques are the factor that the most of the others can affect the sensory characteristics of dairy products.

Results are statistically processed using Microsoft Excel and showed as arithmetic mean, standard deviation and coefficient of variation.

Table 1. Production of organic hard cheese

Technological operations	Technological indicators
Organic milk	Fat: 3.80-3.84% Protein:2.93-3.19% Casein: 2.44-2.80 SFA: 2.16-2.61 USFA: 1.062-1.119 MUFA: 0.575-0.820% PUFA: 0.114-0.639%
Milk pasteurization	72ºC/15 sec
Milk cooling	32ºC
Adding the culture	thermophilic (TCC-20), mesophilic (CHN-22) cultures (80:20)
Adding $CaCl_2$	0.02%
Adding the rennet	after 20 min, 16g/1000 L of milk
Coagulation of milk	30-40 min
Curd cutting	10 min
Curd stirring	10 min
Hot water adding (42ºC)	30%
Stirring	35-40 min
Heating	42ºC, 15-20 min
Curds forming	10-15 min
Take out the cheese curd	Removing the cheese curd and placing into moulds.
Pressing	Lower in the beginning and then gradually increases (2-4-6 bar)
Salting: % of salt pH of brine temperature (ºC) time	 19-20 5.20 11-13 2 days
Draying of cheese	1 day/ 12ºC
Ripening and packaging	12-14ºC, 83-87% R, Ripening is from 3 month to 2 year. In the first 30 days it turned every day, and in the later period once a week.

Popović-Vranješ (2015)

Results and discussion

Quality assurance refers to the overall process of ensuring that the product complies with quality, manufacturing, ingredient and ethical standards required by the customer and by legislation. The assessment of quality depends on measurable criteria which provide information about the product in terms of its microstructure, composition, rheology, sensory properties and/or consumer acceptability (*Law and*

Tamime, 2010). The composition of cheese has an influence on all aspects of quality including sensory properties and texture.
The descriptive statistics variables of attributes of organic cheese samples are shown in Table 2 and Table 3, respectively. The results show that the analysed samples are very uniform in their composition and correspond to the *Serbian Regulations (2014)*. Coefficients of variations (Table 2. and Table 3.) for all observed parameters showed very small deviations indicating that the cheeses have constant quality.

Table 2. Composition of organic hard cheeses

Variables	Range (xmin-xmax)	Arithmetic mean	SD	CV (%)
Dry matter (%)	57.94-64.31	60.27	2.46	4.08
Fat (%)	28.43-32.50	30.51	1.54	5.03
Proteins (%)	21.53-25.70	23.59	1.25	5.31
Salt (%)	1.80-2.08	1.92	0.18	6.09
Moisture (%)	35.69-42.06	39.73	2.46	6.19

SD –standard deviation, CV- coefficient of variation, minimal (min) and maximal (max) values of variables

Cheese contains a high content of biologically valuable protein. The protein content of cheese depends on the variety. It varies inversely with the fat content of cheese and in our investigation the moisture content of cheeses increased with decreasing fat content, and the reduction in fat was compensated for by an increase in protein and salt. Protein content of cheese samples were from 21.5 to 25.7%. Most of the cheese varieties are rich in fat and also varies widely, mainly because of the type of milk. Fat affects cheese firmness, adhesiveness, mouth-feel, flavour. Regarding the fat in dry matter content (50.6%) (Table 3.), our chesses are classified as full-fat cheeses (*Serbian Regulations*, *2014*). Fat in dry matter contents ranged from 48.7 to 51.9, and these range is smaller in comparison with the recommended range for Cheddar cheese which is about 50% to 57% (*Lawrence et al*., 2004). Salt content in the cheese is very important because the relationship between low salt content and pasty, weak bodied cheese has been noted by a number of researchers (*Fox, 1987*).

Owing to the interaction of different compositional parameters (pH, total calcium and ratio of soluble-to-colloidal calcium, moisture, fat and protein), it is difficult to study the exact effects of altering any one compositional parameter, or targeted changes in a group of selected parameters on quality (*Law and Tamime,*

2010).The levels of moisture and salt, the pH and the cheese microflora regulate and control the biochemical changes that occur during ripening and hence determine the flavor, aroma and texture of the finished product. Thus, the nature and quality of the finished cheese are determined largely by the manufacturing steps. Texture of cheeses is related to a complex interaction between chemical composition and ripening parameters. The differences in water content and holes may have caused these differences, with particular regard to hardness (*Innocente et al*., 2002).

According to *Serbian Regulations (2014)* extra hard cheeses contain <51% water in non-fat substance and hard cheeses 49-56%. Values for analysed samples were from 52.49 to 60.10% (Table 3.). Based on these parameters we can conclude that our cheeses according to firmness were between semi-hard and hard cheeses. In accordance with *Lawrence et al. (1984)* optimal value of water on fat-free basis in hard cheese is 52-54%.

Table 3. Relationships between composition and the quality of cheese

Parameters	Range (xmin-xmax)	Arithmetic mean	SD	CV (%)
Fat in dry matter (%) (FDA)	48.68-51.90	50.61	1.27	2.52
Moisture in non-fat –substance (%) (MNFS)	52.49-60.10	57.13	2.55	4.46
Titriable acidity ºSH (TA)	29.28-33.91	31.51	1.55	4.93
S/M (%) (salt/moisture)	4.28-5.74	4.86	0.59	12.06

SD –standard deviation, CV- coefficient of variation, minimal (min) and maximal (max) values of variables

Mistry et al. (1993) estimated similar values of FDM and MNFS for Cheddar (51.8 and 53.7, respectively) and higher values for Swiss cheese (55.0 and 56.3%, respectively).

During the ripening or curing stage, varieties of cheeses acquire their own unique textures, aromas, appearances, and tastes through complex physical and chemical changes. These changes are significantly influenced by storage conditions and very important is controlled as much as possible temperature, humidity, and duration of ripening. Consequently, with the exception of Cheddar cheese, there have been very few published studies attempting to relate composition to quality of different cheese varieties. Five major studies have considered the effects of composition (including level of salt or S/M) and quality/grading scores of mature Cheddars cheese (*Law and Tamime, 2010*). The share salt/moisture moved in the range of 4.28 up to 5.74% which is important because the inhibition of the

utilization of lactose is carried out at ratio greater than 5.8%. Higher S/M, which is caused by higher salt content, inhibits starter culture activity, and results in lower lactic acid production, and a higher pH values (*Pastorino et al., 2003*). The recommended S/M range for Cheddar cheese is about 4.0% to 6.0% (*Lawrence et al., 2004).*

Physical properties of cheese are also influenced by acidity and the pH of the cheese which dictates the state of the calcium-phosphate-casein structure. *Kafili et* al., *(2009)* reported that titratable acidity of all samples did not change significantly in the first month of the ripening, but increased until the end of the ripening due to lactic acid production by microbial flora. Coefficient of variation for titratable showed low-value of variation (4.90%) (Table 3.). The higher titratable acidity results in smaller pH values and minimum pH of cheeses is usually reached within the first few days of maturation. It is regulated by the amount of lactose fermented to lactic acid and the buffering capacity of the curd during manufacturing of the cheese. Buffering capacity is determined by concentrations of undissolved calcium phosphate, caseins and lactate remaining in the cheese (*Lucey and Fox, 1993).*

Conclusion

The aim of this study was to examine the organic production on the composition and characteristics of organic hard cheeses. Cheese making technology has advanced considerably leading to cheese with more consistent composition and quality and production method varied to develop new types of cheese. Good quality of organic milk as a raw material is the first requirement of obtaining quality products. Milk from conventional production from animals that are sick, abused, suffering from mastitis or treated with antibiotics will not have a balanced composition. Many cheeses contain the same or similar components, but in different concentrations and ratios. In our study the moisture content of cheeses increased with decreasing fat content, and the reduction in fat was compensated for by an increase in protein and salt. Regarding the fat content in dry matter (50.6%) our chesses are classified as full-fat cheeses. Indicators of descriptive statistics varied in small limits and were quite balanced. According to water in fat-free matter (52.5 to 60.1%) our cheeses were in the range between hard and semi-hard indicating a lack of ripening control. The share salt/moisture moved in the range of 4.28 up to 5.74%. A smaller titratable acidity contributed to an increase in protein hydration and a higher in cheese moisture and this parameter was in optimal range (29.3-33.9%).

Proizvodnja, sastav i karakteristike organskog tvrdog sira

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Rezime

Organski sirevi predstavljaju proizvode sa dodatom vrednošću koji obezbeđuju male proizvođače mleka sa održivim izvorom prihoda i poseduju potencijal za revitalizaciju farmi, obezbeđenje novih radnih mesta a takodje i nastanak novih varijeteta sireva sa jedinstvenom aromom i novim iskustvom potrošača. U ovom radu je opisana tehnologija proizvodnje tvrdog organskog sira. Proizvodnja organskih sireva mora biti u saglasnosti sa standardima i propisima organske proizvodnje. Punomasno organsko mleko koje ne sadrži rezidue pesticida, hormona i antibiotika predstavlja kvalitetan sirovi materijal za spremanje organskih sireva sa dodatom vrednošću. Istovremeno sa postojećim tehnologijama proizvođači razvijaju i kreiraju nove brendirane proizvode koji su više originalni i prepoznatljivi na tržištu. Cilj svake tehnologije je ponovljiv tehnološki protokol i dobijanje ujednačenog kvaliteta sira sa željenim osobinama.

Istraživanje je obuhvatilo sastav i varijable koje utiču na kvalitet organskih tvrdih sireva (kiselost, sadržaj soli, vode, masti u suvoj materiji i vode u bezmasnoj materiji sira). Ispitivani uzorci sira koji potiču iz različitog vremena proizvodnje su pokazali konstantan kvalitet i dobijeni parametri potvrđuju da analizirani sirevi po svojoj kvalifikaciji odgovaraju punomasnim tvrdim sirevima.

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