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EVALUATION OF QUALITY MEASUREMENT OF OLOMOUC CAKE OF CHEESE (OLOMOUCKÉ TVARŮŽKY) DURING RIPENING

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Abstract

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Olomouc cake of cheese (Olomoucké tvarůžky) is smear-ripened cheese, which is produced from sour industrial curd. *Brevibacterium linens*, which are added during the production process, are reproducing and make gold-yellow smear cover.

The aim of this work was to assess the chemical analysis of the quality of Olomouc cake of cheese. Changes in chemical composition were evaluated during different stages of production and at the same time it was detected whether changes in chemical composition during the manufacturing process are same in spring as well as in summer, without statistically significant differences.

Dry matter of Olomouc cake of cheese was ranged from 35% to 39%. The increase of dry matter during production is evident, but these changes were in the most cases not statistically signifiant ($P > 0.05$). The value of titratable acidity of the cheese considerably changes during the manufacturing process, it has a decreasing tendency. Titratable acidity of cheese after shaping was 106.64 (136.12) SH and at the end of life it was 49.91 (65.06) SH. These changes were very highly statistically significant ($P < 0.001$). Increasing the dry matter of cheese is also proportionatelly increase content of salt in cheese, although this changes are not statistically significant ($P > 0.05$) in cheese from summer period. Content of salt is increased from 5.30% to 5.98%, respectively 6.10%. In spring period the oposite changes in most cases occured ($P < 0.001$), it is increased from 4.27% to 6.20%, respectively 6.94%. When the chemical composition of the cheese in spring and in summer period is compared, there are no significant changes ($P > 0.05$).

ripening, smear-ripened cheese, production

Olomouc cake of cheese is traditional sour cheese produced from industrial curd, which is firstly regulated by grinding and additing of 4.–4.5% salt (Kněz, 1960; Gajdůšek, 2000; Svobodová, 2006) and then stored for a short time between 1 to 2 weeks (Kněz, 1960; Gajdůšek, 2000). Physical and chemical aging occur during this time is the most evident proved to achievement of consistency of curd which is suitable for the production of Olomouc cake of cheese. Curd is better connected and is tough (Kněz, 1960). The addition of salt prevents the growth of undesirable microorganisms and their activities, improves the taste of cheese and firms the skin, affecting the consistency and regulating content of water (Svobodová, 2006). Bacteria *Brevibacterium linens*, added as a secondary culture to the salted curd at the start of production, is reproduced during manufacturing process (Jůzl *et al.*, 2010). The growth of *Brevibacterium linens* on the surface of bacterial surface-ripened cheeses is preceded by the growth of yeasts and moulds. The yeasts and moulds utilize the lactate present in the curd and deacidification of the surface occurs; this pH increase to > 6 enables the growth of *Brevibacterium linens* and other bacteria and eventually cover the whole surface of the cheese (Keller & Puhan, 1985, 1993; Busse, 1989; Eliskases-Lechner a Ginzinger, 1995; Bockelmann, Krusch, Engel, Klijn, Smit, & Heller, 1997c; Roginsky *et al.*,

2003). Proteolysis is considerably stronger at the surface of cheese in comparison with the core (Bockelmann, Hoppe-Seyler, Lick, & Heller, 1998).

Bacterial counts during ripening can exceed 10^9/cm^2 while those of yeasts are generally 10^7/cm^2 (Fox *et al.*, 2004).

Secondary cheese cultures may be defined as those cultures used for the manufacture of cheese, in which their principal function is to develop and control the flavour, colour or texture of the cheese (Bockelmann, 2001; Roginsky *et al.*, 2003) and usually lead to shorter ripening periods of several weeks rather than months (Bockelmann, 2001).

Olomouc cake of cheese obtain quite unique spicy taste, typical flavour, surface covered with golden-yellow smear and cohesive soft consistency with more light centre. Shape is usually as disc, circle, stick or irregular pieces (Jůzl *et al.*, 2010).

Exchange of air ventilation is necessary during drying, otherwise there is risik of a musty and dirty of cheese flavour. Cheese is dried at a temperature from 25 to 32 °C usually for 72 hours at a relative humidity from 50 to 90% (Svobodová, 2006).

Ripening temperature is ranging from 14 °C to 19 °C and the humidity should be at least 95%. Excessive ventilation should be avoided (Kammerlehner, 1995). The development of the surface microflora is also influenced by the presence or absence of oxygen. If the shelves on which the cheese is ripened are solid, the cheeses must be turned frequently; infrequent turning will limit the amount of oxygen that reaches the surface of the cheese in contact with the shelf, thereby limiting microbial activity to the upper surface and the perimeter of the cheese (Fox *et al.*, 2004). Repeated turning of cheeses and surface treatment by repeated smearing are the most important for ripening. (Bockelmann and Hoppe-Seyler, 2001). Content of salt, pH, and moisture also affect the composition of the surface microflora (Fox *et al.*, 2004).

During the manufacture of Olomouc cake of cheese it is necessary to pay attention to the quality of feedstock and to observe the technique that is prevent before contamination by undesirable microorganisms. Olomouc cake of cheese is the typical food that gets ideal properties after a period of maturation. These properties are decisive for the consumer who decides on the success of the product. Determination of the composition can also be used to manufacturers for the control of quality (Jůzl *et al.*, 2010).

The aim of this work was to monitore changes in chemical composition of Olomouc cake of cheese at different stages of production and simultaneously judge whether changes in chemical composition are progress in spring and summer without statistically signifiant differences, therefore under the same conditions.

MATERIALS AND METHODS

For chemical analysis samples of product of one rank at various stages of production and finished product were taken. Samples were taken from the producer of Olomouc cake of cheese during the storage period according to the following scheme:

- T1 – sample of mixture of curds after salting, the addition of cultures and the formation. It is 6. day from start of production.
- T2 – sample after drying and ventilation (7.–8. day).
- T3 – sample at the end of the production process which is ready for packing and expedition (9.–11. day).
- T4 – finished product which is wrapped and stored at 5 °C at the end of life (38.–45. day).
- T5 – finished product which is wrapped and stored at 20 °C at the end of life (38.–45. day).

Cheese was formed as disk and was taken during the spring and summer period. The experiment was based on evaluation of changes in the chemical composition of Olomouc cake of cheese during their manufacture. In every phase six samples were taken from which were determined following parameters: dry matter, titratable acidity, activ acidity and content of sodium chloride. Differences between spring and summer cheeses were mutually compared. Samples were always pre-grated and thoroughly homogenized. Determining of dry matter was done in dryer Binder according to ČSN EN ISO 5534. The active acidity was determined potentionmetrically by using microprocessor digital pH meter WTW pH 95 according to ČSN 57 0107. Titratable acidity was determined by titration of premeasured lotion NaOH ($c = 0{,}25$ mol$\times$ l^{-1}) for the fenoftalein indicator accorsing to ČSN 57 0107, segment n. 21. The content of salt was detected by direct titration using silver nitrate ($c = 0{,}1$ mol$\times$ l^{-1}) for the presence of potassium chromate accodring to ČSN EN ISO 5943.

Statistical evaluation

Program UNISTAT 05.01 was used for statistical analysis that is analysis of variance with multiple comparison. Tukey test was performed to determine whether statistically significant differences exist. Levels of significance were indicated in the appropriate tables.

RESULTS AND DISCUSSION

Olomouc cake of cheese was analysed during the phase of production according to scheme in materials and methods. Results of individual chemical analysis as well as statistically significant are showed in following table.

Dry matter of Olomouc cake of cheese was ranged from 35% to 39%. From Tab. I the increase of dry matter during production is evident, but these changes were in most cases not statistically significant, in some measurements the change was slightly bellow significant limit ($P < 0.05$).

I: *Changes of chemical components of Olomouc cake of cheese during ripening (n = 6)*

	T1 (n = 6)	T2 (n = 6)	T3 (n = 6)	T4 (n = 6)	T5 (n = 6)
Dry matter (%)					
- spring	35.65 ± 1.31	38.20 ± 0.86	37.31 ± 0.58^{a}	39.15 ± 1.83^{b}	37.94 ± 0.72
- summer	34.77 ± 1.19^{a}	37.66 ± 0.36	37.25 ± 0.67	37.62 ± 1.41	38.59 ± 1.15^{b}
pH					
- spring	4.65 ± 0.72^{A}	5.53 ± 0.05^{B}	6.22 ± 0.06^{C}	6.75 ± 0.26^{D}	7.16 ± 0.13^{E}
- summer	5.03 ± 0.70^{A}	5.58 ± 0.06^{a}	6.03 ± 0.04^{b}	6.90 ± 0.35^{C}	7.06 ± 0.21^{C}
SH					
- spring	136.12 ± 14.41^{A}	89.18 ± 5.24^{B}	71.41 ± 4.29^{C}	42.08 ± 8.23^{D}	49.91 ± 9.29^{D}
- summer	106.64 ± 4.74^{A}	76.72 ± 3.21^{B}	63.27 ± 5.71^{C}	45.74 ± 6.15^{D}	65.06 ± 1.61^{C}
NaCl (%)					
- spring	4.27 ± 0.70^{A}	5.49 ± 0.03^{B}	5.91 ± 0.10^{C}	6.20 ± 0.46^{C}	6.94 ± 0.33^{D}
- summer	5.30 ± 0.84	4.99 ± 0.38	5.10 ± 0.22	5.98 ± 1.04	6.10 ± 0.95

a, b, c, d, e – various index between columns shows statistically significant difference ($P < 0.05$)
A, B, C, D, E – various index between columns shows highly statistically significant difference ($P < 0.001$)

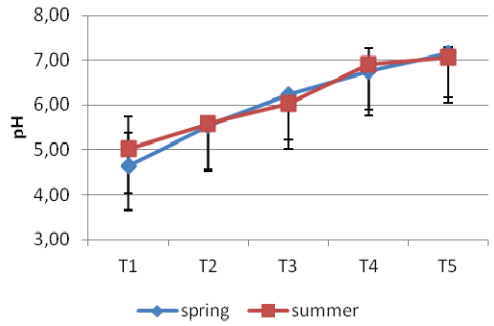
Cheese proved dry matter 34.77 (35.65) % before drying (T1), whereas after drying and ventilation (T2) percentage of dry matter increased to 37.65 (38.20) %, which corresponds to the requirements of the manufacturer. The manufacturer notes that the purpose of this production step is staying of semi-finished product in the oven for predefined time to achieved by exchanging the air the desired content of dry matter between 36% to 38% and rising of proteolytic microflora on the surface of the cheese. In the next stage of the production process (T3) the dry matter was re-reduced to 37.25 (37.31) %. This reduction is due to washing of cheese, which is part of the manufacturing process. Svobodova (2006) states that from the surface of cheese the oxidation microflora has to be removed by washing the surface, thereby the surface acidity and content of salt is reduced and also dry matter which is essential for production of smeard will increase. Dry matter was again risen at the end of life (T4, T5) using both dry ripening temperatures. According to the manufacturer dry matter should be 35 to 40% at the end of life. Both methods of preservation of Olomouc cake of cheese satisfied these values.

Industrial curd, which is used for the production of Olomouc cake of cheese, has the titratable acidity 120 to 160 SH. The acidity is caused by lactic acid and casein. The high acidity of the curd is unsuitable for further microbiological processes, thus it is reduced by neutralization of acid sodium carbonate or calcium carbonate (Görner, Valík, 2004). Tab. I shows that the value of titratable acidity of the cheese considerably changes during the manufacturing process, it has a decreasing tendency. Titratable acidity of cheese after shaping (T1) in summer period was 106.64 SH that meet the requirements of the producer, who states that the curd is combinated according to different properties of the quark in order to achieve the best mixture which is suitable for formation (titratable acidity of this mixture is from 105 to 115 SH, content of NaCl from 4.5 to 5.5%, dry matter from 32 to 34%, the consistency is solid, continuous, non-sticky, soft). To the contrary, titratable acidity in spring period was 136.12 SH and a mixture of curd for formation was not sufficiently neutralized. During the drying and ventilation (T2), titratable acidity decreased (89.18 respectively 76.72 SH), which was caused by augmentation of oxidation yeasts. The yeasts with the access of air oxygen oxidise excess lactic acid to CO_2 and H_2O and thus the surface acidity of cheese was decreased (Doležálek, 1962; Plocková, Březina, 1988; Zimák, 1988; Görner, Valík, 2004). Several other authors state that the yeasts and moulds deacidification of the surface occurs; this pH increases to > 6 enables the growth of *Brevibacterium linens* and other bacteria and eventually covers the whole surface of the cheese (Keller & Puhan, 1985; Busse, 1989; Eliskases-Ginzinger and Lechner, 1995; Bockelmann, Krusch, Engel, Klijn, Smit, Heller, 1997c; Roginsky *et al.*, 2003).

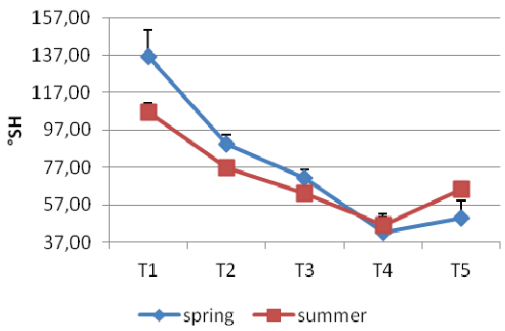
The next step is maturation of cheese (T3), proteolytic aerobic bacteria are multiplied on the surface and these activities lead to degradation of protein on the surface and form a typical golden-yellow to orange smear (Olšanský *et al.*, 1956). Titratable acidity is still decreasing (71.41 respectively 63.27 SH) and the pH increasing (6.22 respectively 6.03). According to Nedomová and Cwiková (2006) olomouc cake of cheese is usually wrapped when its maturity is 1/3 of cut. The higher value of titratable acidity of cheese which is stored at 20 °C (49.91, respectively 65.06), compared with cheese stored at 5 °C (42.08, respectively 45.74) is probably caused by augmentation of lactic acid bacteria that consume lactose and convert it to lactic acid, which increases the acidity of the cheese. Olšanský (1958) also reached the same conclusion. Between the phases of cheese production very highly statistically significant differences ($P < 0.001$)

were shown. The exceptions were T4 and T5 spring samples as well as T3 and T5 summer samples. The values were not statistically significant, but also the change of titratable acidity due to ripening of cheese is visibled. Values of pH should increase due to decreasing values of titratable acidity during production, which is also confirmed in Tab. I. Very highly statistically significant difference ($P < 0.001$) in pH values, except for samples T4 and T5 in summer period as well as in titratable acidity was found among all samples.

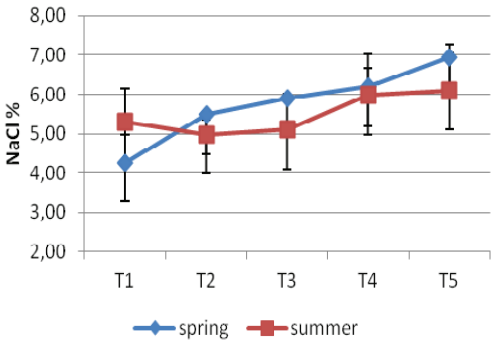
The results show that increasing the dry matter of cheese is also proportionatelly increase content of salt in cheese, although this changes are not statistically significant in cheese from summer period. Content of salt is increased from 5.30% to 5.98%, respectively 6.10%. In spring period the oposite changes in most cases occured. Content of the salt after formation was 4.27% and at the end of life 6.20%, respectively 6.94%. From amount of salt at the end of life it is evident that salt exceeded the value required by the manufacturer, precisely 5.5%,



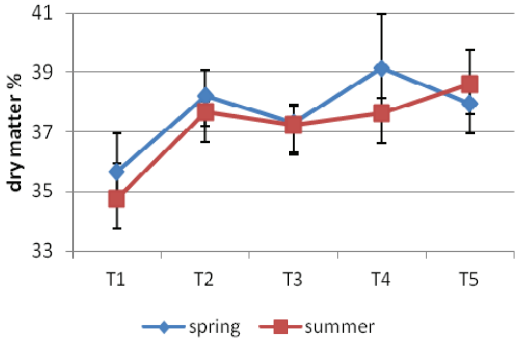
1: *Changes of pH between season*



2: *Changes of SH between season*



3: *Changes of NaCl between season*



4: *Changes of dry matter between season*

II: *Changes of chemical parameters of Olomouc cake of cheese between season of spring and summer (n=6)*

		pH	SH	NaCl (%)	Dry matter (%)
T2	Spring	5.53 ± 0.05	89.18 ± 5.24	5.49 ± 0.03	38.20 ± 0.86
	summer	5.58 ± 0.06	76.72 ± 3.21	4.99 ± 0.38	37.66 ± 0.36
	conclusiveness	SN	**	**	SN
T3	Spring	6.22 ± 0.06	71.41 ± 4.29	5.91 ± 0.10	37.31 ± 0.38
	summer	6.03 ± 0.04	63.27 ± 5.71	5.10 ± 0.22	37.25 ± 0.67
	conclusiveness	**	*	**	SN
T4	Spring	6.75 ± 0.26	42.08 ± 8.23	6.20 ± 0.46	39.15 ± 1.83
	summer	6.90 ± 0.35	45.74 ± 6.15	5.98 ± 1.04	37.62 ± 1.41
	conclusiveness	SN	SN	SN	SN
T5	spring	7.16 ± 0.13	49.91 ± 9.29	6.94 ± 0.33	37.94 ± 0.72
	summer	7.06 ± 0.21	65.06 ± 1.61	6.10 ± 0.95	38.59 ± 1.15
	conclusiveness	SN	**	SN	SN

NS..... there is no statistically significant difference ($P > 0.05$)
*..... there is statistically significant difference ($P < 0.05$)
**..... there is highly statistically significant difference ($P < 0.01$)

in both ways of storing of cheese, as well as in spring and summer period.

Statistically significant ($P < 0.05$) and statistically highly significant ($P < 0.01$) differences were found only in the measured values of salt and acidity in the steps of drying and ventilation and samples at the end of the production process, when cheese produced in spring with cheese in summer were compared (Tab. II). At the end of shelf life there were not any statistically significant differences ($P > 0.05$) of samples stored in the refrigerator. Changing of acidity is the same in spring as well as in summer as it can be depicted in Fig. 1 or 2. Titratable acidity in cheese kept at 20 °C was again increased. According to Kněz (1960) *Geotrichum candidum* is mold occuring in surface smear-ripened cheeses. It grows between 15 to 25 °C, it is able to grow in 10% NaCl and also in medium with high acidity (pH around 4). It synthesizes proteolytic and lipolytic enzymes. Flow of cheese is also hazardous, it is caused by sporulation aerobic proteolytic bacteria of the genus *Bacillus* that may reproduce in the curd during its storage at higher temperatures. This increase of titratable acidity is probably due to a defect of microbial origin.

Changes of dry matter and content of salt during ripening can be see in Fig. 3 and 4. In both pictures slightly differences between spring and summer samples can be observed. Reduction of dry matter of cheese, which is caused by washing of cheese is between T2 and T3 stages, in the other steps dry matter again increases. Repetitive signifiant decrease of dry matter of the cheese from spring period, which is stored at 20 °C, it may be due to microbial defect. There is diferent amount of salt in the phase of the formation of T1, which may be due to the selected dose of the addition of salt to the curds.

CONCLUSIONS

By examining the results of chemical analyzes of Olomouc cake of cheese was found that dry matter increase during the production. The increasing of dry matter results in increasing of salt in finished product. The values of titratable acidity decreased in all stages during production and the value of pH was shifted from acidic to neutral course. For re-acidification gain only at sample stored at room temperature, which apparently was caused by the development of undesirable microflora. Temperature of storage has large influence on the acidity of the cheese and should be thoroughly checked. Due to the fact that the cheese ripens over a long period of time at the consumer side we can say that the consumer may choose stage of consuming according to aging. It is up to consumer whether he or she prefers stronger taste or not – the older the cheese is the stronger taste it has. Also there are changes between storage at room temperature and storage in refrigerator and it is therefore important to pay attention to ensure product safety. When the chemical composition of the cheese in spring and in summer period is compared, there are no significant changes. The same conditions were observed during the production.

SUMMARY

The aim of this work was to monitore changes in chemical composition of Olomouc cake of cheese at different stages of production and simultaneously judge whether changes in chemical composition are progress in spring and summer without statistically signifiant differences, therefore under the same conditions. Dry matter of Olomouc cake of cheese was ranged from 35% to 39%. The increase of dry matter during production is evident, but these changes were in the most cases not statistically signifiant ($P > 0.05$). After drying and ventilation percentage of dry matter increased to 38.20 respectively 37.66 %, which corresponds to the requirements of the manufacturer. In the next stage of the production process, the dry matter was re-reduced to 37.31 respectively 37.25%. According to the manufacturer dry matter should be 35 to 40% at the end of life. The value of titratable acidity of the cheese considerably changes during the manufacturing process, it has a decreasing tendency. Titratable acidity of cheese after shaping in summer period was 106.64 SH that meet the requirements of the producer. To the contrary, titratable acidity in spring period was 136.12 SH. During the drying and ventilation, titratable acidity decreased (89.18 respectively 76.72 SH), which was caused by augmentation of oxidation microflora. The typical golden-yellow to orange smear is evolved by the next maturation of cheese and titratable acidity is still decreasing (71.41, respectively 63.27 SH) and the pH increasing (6.22 respectively 6.03). The higher value of titratable acidity of cheese which is stored at 20 °C, compared with cheese stored at 5 °C is probably caused by augmentation of lactic acid bacteria. Increasing the dry matter of cheese is also proportionatelly increase content of salt in cheese, although this changes are not statistically significant ($P > 0.05$) in cheese from summer period. Content of salt is increased from 5.30% to 5.98%, respectively 6.10%. In spring period the oposite changes in most cases occured ($P < 0.001$). Content of the salt after formation was 4.27% and at the end of life 6.20%, respectively 6.94%. The values of salt at the end of life it is evident that salt exceeded the value required by the manufacturer, precisely 5.5 %, in both ways of storing of cheese, as well as in spring and summer period. When the chemical composition of the cheese in spring and in summer period is compared, there are no significant changes ($P > 0.05$). The same conditions were observed during the production.

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