Physicochemical and Sensory Properties of Whey Cheese with Pine Nuts

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ABSTRACT
This study aimed to develop a value-added whey cheese through addition of pine nuts. Therefore, different concentrations of pine nuts [2, 4, 6 and 8% (w/w)] were added to whey cheese. The study was designed to evaluate the influence of pine nuts on physicochemical and sensory properties of whey cheese. The addition of pine nuts resulted in an increase in fat content and total solids and a decrease in moisture content. However, no statistically significant difference was found in pH values. Sensory analysis was performed using the 9-point hedonic scale, with selected assessors. The whey cheese sample with 4% pine nuts was the most appreciated (7.6 points), followed by the classic whey cheese, whey cheese with 6 and 8% pine nuts (7.4 points), and whey cheese with 2% pine nuts (7.3 points). Nevertheless, the sensory characteristics of whey cheese were not significantly influenced by the addition of pine nuts. Whey cheese sensory profiling was successful in differential characterization of whey cheese samples.

Keywords: addition, pine nuts, physicochemical properties, sensory properties, whey cheese.

INTRODUCTION
Whey cheeses are solid, semi-solid, or soft products which are obtained by the concentration of whey and moulding of the concentrated product or by the coagulation of whey through heating with or without the addition of acid (CXS 284-1971). Whey is the by-product from cheese or casein production (Mollea et al., 2013). Four major types of whey are identified (Gordon, 1997): (i) sweet whey from the manufacture of cheeses coagulated by rennet at pH 6.0 to 6.4, (ii) acid cheese whey from the manufacture of cheeses coagulated at pH 4.5 as a result of lactic acid production by starter bacteria, (iii) acid casein whey from the manufacture of acid casein (pH 4.5), and (iv) rennet casein whey from the manufacture of rennet casein (pH 6.6). Whey is a dilute product with a total solids of about 6.5%. The solids contain lactose, whey protein, ash, lactic acid and fat (Tsakali et al., 2010). The major components among whey proteins are β-lactoglobulin (β-LG), α-lactalbumin (α-LA), bovine serum albumin (BSA) and immunoglobulin (IG), representing 50%, 20%, 10%, and 10% of the whey fraction, respectively (Mollea et al., 2013).

Whey cheeses are manufactured all over the world, usually according to traditional small-scale processing (Pintado et al., 2001). The Romanian type of whey cheese is named Urdă. Alongside Burduf cheese (Pop et al., 2013) and Telemea (Buruiana and Farag, 1980) are most commonly consumed Romanian cheeses. Traditionally, the Romanian Urdă is obtained from sheep whey at sheepfold. In recent years, much interest has been paid to whey valorization. Presently, Urdă is produced on the industrial scale.
Pine nuts are small edible seeds that grow underneath the cone scales. These seeds have a high level of lipids. Oleic and linoleic acids represent together more than 75% of total fatty acids. The main sugar constituent is sucrose but contains raffinose and stachyose also. The preponderant amino acids in pine nuts are glutamic acid, arginine, and aspartic acid (Ruggeri et al., 1998).

The main purpose of this research was to obtain a fortified whey cheese by the addition of pine nuts. Four different levels of pine nuts [2, 4, 6, and 8% (w/w)] were added to whey cheese after processing. This study was designed to evaluate the effect of fortification on whey cheese physicochemical and sensory properties and to establish the optimal quantity of pine nuts addition based on consumer preferences. To the best of our knowledge, this is the first study that approaches the fortification of whey cheese with pine nuts.

MATERIALS AND METHODS

Materials

Acid whey and cream, acquired from a local dairy company, were the raw materials used for whey cheese manufacturing. Pine nuts added in whey cheese were purchased from a Romanian spice company.

Methods

Manufacture of whey cheese with pine nuts

The manufacture of whey cheese took place in the Dairy Pilot Plant from Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania. The technological process for whey cheese production consisted in heating (80°C for 60 min), moulding, draining (18-20°C for 10-12 h), cooling (4°C for 24 h), removal from moulds, packaging and refrigeration storage (4°C). The cream (24% fat) is added before heating. Pine nuts were roasted and milked then added to the whey cheese in different concentrations [(2, 4, 6 and 8% (w/w)].

Chemical analysis of pine nuts

Determination of fat content was performed using a Soxhlet apparatus (Velp Scientifica Srl, Milano, Italy) and protein content using a Kjeldahl apparatus (JP Selecta SA, Barcelona, Spain). The AOAC Official Method 948.22 described by Chung et al. (2013) was used for lipids extraction. The AOAC Official Method 925.40 was used for determination of moisture content, AOAC Official Method 950.48 for protein content and AOAC Official Method 923.03 for ash content (Chung et al., 2013).

Physicochemical analysis of whey cheese with pine nuts

Determination of fat content was performed using the Van Gulik method described by ISO 3433:2008. Total protein content was determined using the Kjeldahl method described in ISO 8968-1:2014 and total solids content according to the ISO 5534:2004 (IDF 4:2004) method (Guş and Semeniuc, 2010). The results are expressed in percentage. pH was measured at room temperature using a Consort C535 pH meter (Consort nv, Turnhout, Belgium). For each physicochemical parameter, two replicates per sample were run.

Sensory evaluation of whey cheese with pine nuts

Sensory characteristics of samples were evaluated by a panel of 30 trained assessors, with a mean age of 24. Whey cheese samples were presented in random order in plastic cups. The 9-point hedonic test was used to evaluate all whey cheese samples (1 – dislike extremely, 9 – like extremely). Appearance, color, consistency, smell, taste, flavor, and overall acceptability were the sensory attributes evaluated.

Statistical analysis

Minitab statistical software (version 16.1.0, LEAD Technologies, Inc.) was used to perform statistical analysis. One-way analysis of variance (ANOVA) was applied to determine whether there are any significant differences between treatments. Tukey’s test (α=0.5) was used to determine the level of significance. Correlations among data were calculated using Pearson’s correlation coefficient.

RESULTS AND DISCUSSION

Considering that a production process not currently used has been applied, the whey cheese with pine nuts is a novel food (Semeniuc et al., 2011). This process significantly changes
the composition of whey cheese and affects its nutritional value.

Characterization of pine nuts

The total solids content found in pine nuts is 97.2%, moisture content 2.8%, fat content 64.1%, protein content 17.1%, and ash content 2.0%. Chung et al. (2013) have found values of 1.9% fat, 17.3% proteins, 69.8% moisture, and 2.2% ash, similar with levels obtained in the present study.

Effect of pine nuts addition on whey cheese physicochemical properties

The addition of pine nuts affects the physicochemical composition of whey cheese. Table 1 contains the values of physicochemical parameters for whey cheese samples tested.

The addition of pine nuts has a significant effect on whey cheese fat content ($p < 0.01$), total solids ($p < 0.001$), moisture content ($p < 0.001$), and pH ($p < 0.01$) but no significant effect on proteins ($p > 0.05$). The fat content and total solids increases with the amount of added pine nuts.

The strong positive correlation found between total solids and fat content ($r^2 = 0.99; p < 0.001$) confirm the above statement. Table 2 shows the correlation coefficients between physicochemical characteristics of whey cheese.

Protein content and pH vary slightly. The fat content ranges from 19.0 to 22.0%, protein content from 17.5 to 18.0%, total solids from 43.89 to 48.95%, moisture content from 51.05 to 56.12%, and pH from 5.49 to 5.54. According to the Codex standard for whey cheeses (CODEX STAN 284, 1971), the obtained product is classified as creamed whey cheese. The composition of creamed whey cheese must contain a minimum of 33% fat in dry matter (fat i.d.m.). The fat i.d.m. content of whey cheese formulas ranges from 43.3 to 45.4%. All whey cheese formulations meet the Codex standard requirements.

Effect of pine nuts addition on whey cheese sensory properties

The addition of pine nuts does not significantly influence the sensory properties of whey cheese.

### Tab. 1. Physicochemical properties of whey cheese samples

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Fat (%)</th>
<th>Proteins (%)</th>
<th>Total solids (%)</th>
<th>Moisture (%)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC0</td>
<td>19.00±0.000c</td>
<td>17.5±0.502</td>
<td>43.89±0.177c</td>
<td>56.12±0.177c</td>
<td>5.49±0.007c</td>
</tr>
<tr>
<td>WC2</td>
<td>19.50±0.707bc</td>
<td>18.0±0.368</td>
<td>44.80±0.014cd</td>
<td>55.20±0.014cd</td>
<td>5.50±0.007c</td>
</tr>
<tr>
<td>WC4</td>
<td>20.75±0.354bc</td>
<td>17.9±0.636</td>
<td>46.29±0.014de</td>
<td>53.71±0.014de</td>
<td>5.50±0.007c</td>
</tr>
<tr>
<td>WC6</td>
<td>21.25±0.354d</td>
<td>17.9±1.004</td>
<td>47.67±0.177d</td>
<td>52.34±0.177d</td>
<td>5.50±0.000c</td>
</tr>
<tr>
<td>WC8</td>
<td>22.00±0.000a</td>
<td>17.7±0.750</td>
<td>48.95±0.155e</td>
<td>51.05±0.155e</td>
<td>5.50±0.014c</td>
</tr>
</tbody>
</table>

Note: WC0 - whey cheese without pine nuts; WC2 - whey cheese with 2% pine nuts; WC4 - whey cheese with 4% pine nuts; WC6 - whey cheese with 6% pine nuts; WC8 - whey cheese with 8% pine nuts. Different letters (on column) indicates statistically significant differences at $p < 0.05$ (Tukey’s test). Significance of effect (SE): ns not significant, $p > 0.05$; *significant $p \leq 0.05$; **very significant $p \leq 0.01$; ***extremely significant $p \leq 0.001$

### Tab. 2. Pearson’s correlation coefficients between sensory and physicochemical characteristics of whey cheese

<table>
<thead>
<tr>
<th>Physicochemical characteristics</th>
<th>Fat (%)</th>
<th>Proteins (%)</th>
<th>Total solids (%)</th>
<th>Moisture (%)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat (%)</td>
<td>-</td>
<td>0.00ns</td>
<td>0.99***</td>
<td>0.99***</td>
<td>0.22ns</td>
</tr>
<tr>
<td>Proteins (%)</td>
<td>0.00ns</td>
<td>-</td>
<td>0.01ns</td>
<td>0.01ns</td>
<td>0.15ns</td>
</tr>
<tr>
<td>Total solids (%)</td>
<td>0.99***</td>
<td>0.01ns</td>
<td>-</td>
<td>-</td>
<td>0.24ns</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>-</td>
<td>0.01ns</td>
<td>-</td>
<td>-</td>
<td>0.24ns</td>
</tr>
<tr>
<td>pH</td>
<td>0.22ns</td>
<td>0.15ns</td>
<td>0.24ns</td>
<td>0.24ns</td>
<td>-</td>
</tr>
</tbody>
</table>

Significance: ns not significant, $p > 0.05$; *significant $p \leq 0.05$; **very significant $p \leq 0.01$; ***extremely significant $p \leq 0.001$. 

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However, panelists prefer the whey cheese with pine nuts. Figure 1 illustrates the sensory profile of all treatments.

Whey cheeses are differentiated based on appearance, color, consistency, smell, taste, flavor, and overall acceptability. The whey cheese sample with 4% pine nuts is the most appreciated by panelists in terms of appearance, color, consistency, and taste.

**CONCLUSION**

This study is the first that reports the fortification of whey cheese with pine nuts. The results of the current research reveal new perspectives for the innovative application of pine nuts in cheese products. The whey cheese with 4% pine nuts is the best in all aspects of quality. These findings may be useful to dairy manufacturers to obtain new types of whey cheese.

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