Chemical Explanation of an Original Ethno-procedure for Curdling Milk using Natural Brine

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The paper aims to provide the scientific explanation for an original folk procedure for curdling milk, recorded in certain areas with salt springs from the Eastern Subcarpathians of Romania. The chemical analyses of the brine collected from a number of salt springs indicate, primarily, a very high content of Ca^{2+}, Sr^{2+} and Mg^{2+} cations, ions responsible for the coagulation of the whey casein or other proteins.

Keywords: salt springs, chemical analyses, milk curdling

As early as the publication of the first Romanian ethnographical study focusing on the exploitation of salt springs, a distinction has been operated between brines from salt springs with general uses and brines with special uses [1-3]. The latter, according to the ethnographical information available at that time, were concentrated in a microregion of the Bistriţa River in its mountainous sector that comprised the villages of Fărcaşa, Stejaru, Pârâul Pântei, Sabasa, and Borca (Neamţ County), settlements in which the denizens used natural brine for curdling milk (particularly cow milk) [4]. The ethnoarchaeological research subsequently conducted under two projects (CNCSIS no 185—2007–2008, CNCSIS no 414/2007—ethnosal.uaic.ro.), through on-site ethnographic inquiries, have advanced our understanding of the phenomenon and have identified new salt springs with similar uses at Neguleşti, Piatra Şoimului commune, Neamţ County [5] and Sadova, Sadova commune, Suceava County (unpublished investigation).

This article is part of a wider research endeavour, initiated within the framework of the EthnosalRo project, on the scientific underpinning of various ethnographical practices [6-8]. The main goal of the article is to present the results of the first chemical analyses, the necessity of which has already been emphasised [5, 9], that can explain from a scientific standpoint the process of cow and sheep milk coagulation by adding a small quantity of saline water from the springs in Farcaşa and Stejaru (Neamţ County).

The ethnographical research in the area commenced in 2007, and continued in 2008 [9] and 2010. With reference to the topic of the current paper, data and considerations regarding the localisation, geographical position, environmental features of the area around the two salt springs, and their catchment systems, have been published [10]. Similarly, information has been recorded regarding the use of saline water for coagulating cow milk. Very important are the observations concerning the process in question made during a live demonstration of the practice: "the villager put one litre of cow milk to boil and, when the water started to boil, she added 100mL of brine and turned off the fire. In less than 2–3 min, the milk started to coagulate and, after a few minutes, the cheese was put to drain in a straining bag" [10]. The inquiry conducted in 2012 offered a slightly different version by Fărcaşa-inhabitant Vasile Tănase: "(Back) home we boil the sheep or cow milk, we leave it to cool down a little and, when it reaches a temperature the elbow or the finger can tolerate, on the edge of the vessel, inside it, we sprinkle brine, for every 5 litre about a mug of 2-300 g, we cover it and leave to curdle, then we pass it through a muslin and obtain the cheese, but the cheese is not salty". Two inhabitants from Stejaru, gave, in their turn, another version: "for 5 L of milk, when it boils, you put 50–100 g (of brine) poured at the inside edges of the pot, then stir it with the roller and the milk will curdle". A similar procedure, this time to produce *urda*[**], was described to us in Sadova by Eusebie Zbranca, a villager deep-versed in local customs: "from cheese you get whey, which you round off with milk (for 100 L of whey you put 10 L of milk) and then, when it is close to boiling, you put with a spoon about 500 g of brine and you get cheese". One of the authors of this article recollects that during his childhood in his native village (Câmpeni, Pârjol commune, Bacău County), curdling sheep milk was done, besides with rennet obtained from stomachs of lambs (likewise preserved using natural brine from salt springs), also with a small quantity of brine, respectively 1 spoon for every litre of sheep milk.

Experimental part

The two samples collected from the salt springs in Fărcaşa and Stejaru were analysed in order to determine their chemical composition and other physical and organoleptic characteristics, using a series of instrumental techniques.

The EDX analysis

The analysis used a SEM scanning electron microscopy (model VEGA II LSH) (Czechia), coupled by a EDX detector (type QUANTAX QX2) (Germany). The elemental chemical composition was determined on the basis of the EDX spectrum, in terms of gravimetric and atomic percentages on a microstructure at a zoom factor of ×500.

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** *A traditional Romanian dairy product produced from whey left over from the production of cheese, similar to the Italian ricotta. Although referred to as cheese, it is not properly a cheese because it is not produced by coagulation of casein. Rather, it is made by coagulating other milk proteins, notably albumin and globulin, left over in the whey that separates from the milk during the production of cheese.*

Determining the concentration. The concentration was determined by dry-evaporating a predetermined volume of brine in a porcelain crucible, through the gravimetric method [2-4].

Determining the density. For determining the density, we employed a 50 cm^3 pycnometer and a PARTNER model AS 220/C/2 analytical balance.

Results and discussions

The samples of brine from Stejaru and Fărcasa were collected directly from the source (springs) on of 4th September 2012, and displayed the following organoleptic characteristics: a slight brownish colour, which in time left weak deposits of brown floccules from halogens in the form of oxyhydroxides. The water from Stejaru had a salty taste and an intense iodine/bromide smell, while the one from Fărcasa tasted like raw salt.

The concentration of salts recrystallized through evaporation is 11.654% for the brine from Stejaru, and 4.9128% for the one from Fărcasa.

The pycnometer showed density values of 1.0888 g/cm^3 for the Stejaru brine, and of 1.03675 g/cm^3 for the Fărcasa brine, respectively. These numbers correspond, according to the graph of density as a function of the concentration, to a salt content of 11.615% (1.0875 g/cm^3) for the Stejaru brine, and of 5.002% (1.0375 g/cm^3) for the brine from Fărcasa. The results are within the admissible error margins.

Table 1
CHEMICAL COMPOSITION OF THE RECRYSTALLIZED SALT FROM FĂRCAŞA SALT SPRING, NEAMŢ COUNTY

Element	Weight (%)	Atomic (%)	Error (%)
Chlorine	43.34303	31.43714	1.752658
Sodium	11.52377	12.88941	0.954328
Calcium	10.27073	6.589741	0.382839
Strontium	1.91484	0.561956	0.130411
Potassium	1.372454	0.902637	0.081958
Magnesium	1.10981	1.174157	0.114128
Iron	0.501241	0.230791	0.048494
Iodine	0.910068	0.184404	0.067938
Bromine	0.518025	0.166708	0.06025
Oxygen	28.53603	45.86305	6.205338
	100	**100**	

According to the EDX data, on the basis of the spectrum acquired on the surface of the SEM microphotogram, in tables 1 and 2 we can observe that both brines contain, alongside the sodium chloride, a very high content of Ca^{2+}, Sr^{2+} and Mg^{2+} cations, ions responsible for the coagulation of the whey casein or other proteins. The other cations, namely traces of K^+ and Fe^{2+}, alongside I^- and Br^-, have a synergic action, to the same effect. We underline two aspects, one negative, the presence of the Sr^{2+} cation whose radioactivity is not known, but which is most

Table 2
CHEMICAL COMPOSITION OF THE RECRYSTALLIZED SALT FROM STEJARU SALT SPRING, NEAMŢ COUNTY

Element	Weight (%)	Atomic (%)	Error (%)
Chlorine	49.15235	36.77795	1.871505
Sodium	16.88524	19.48342	1.303599
Calcium	6.459601	4.275552	0.244447
Strontium	2.158784	0.653579	0.138622
Magnesium	0.935964	1.021541	0.102218
Iron	0.478875	0.227465	0.048977
Potassium	0.104167	0.070675	0.034373
Iodine	0.678974	0.141928	0.060807
Bromine	0.775726	0.257533	0.072079
Oxygen	22.37032	37.09035	5.377075
	100	**100**	

certainly eliminated when the cheese is separated via the aminoacids contained by the whey, and the other positive, namely the content of K^+, which makes it possible, through the addition of brine to the curdling milk, to increase its solubility during the coagulating processes, forcing a part of it to remain in the cheese. The role of K^+ from alimentary sources for the proper functioning of the cardiac muscles and of the overall muscular system is well known.

High Ca^{2+} and Mg^{2+} cation values were recorded during our research of the salt springs from the Cacica and Stulpicani area, though the ethnographic inquiries on the current uses failed to report the use of brines from these springs for coagulating milk.

Most often, milk curdling is done through thermal input, being well known that proteins denaturated in saline, acidic or basic mediums, but also at temperatures over 80° C.

With respect to the practices encountered at Câmpeni-Pârjol (Bacău County), the addition of a small quantity of natural brine for coagulating sheep milk using lamb rennet can be explained by the fact that the villagers are not unaware of the antimicotic and antiviral properties of salt (easy spoilage is prevented if during the curdling process and after separating the whey in the cheesecloth a spoonful of brine is added for every litre of milk, before the latter is put on fire); this adjuvant is particularly useful when the coagulating temperature is below 80° C, and the milking is done in precarious hygiene conditions where the possibility that particles of animal faeces will fall into the milk is not excluded.

Alongside the temperature and the salt acting as a coagulating agent and accelerator, an important role is played by the physical agitation of the milk, but only in one direction, as to damage the oligomeric protein structures which would otherwise trigger a hydrolysis process that would lead to the interruption of the precipitation process.

Conclusions

The continuation of the chemical analyses for all the springs from Romania with saline water used for curdling

milk can further advance our knowledge of these customs that paint a true ethno-food science of the Romanian village. Sometimes in the distant past, people discovered that this natural resource can be used with success to this peculiar purpose. This discovery was locally integrated and capitalised upon as part of the ethnomanagement of the salt springs from Romania, a remarkable phenomenon on account of its amplitude and variety of manifestations [11].

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