

Control of Ewe and Goat Cheeses Labelling on the Croatian Market

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Abstract

The aim of the research was to examine ewe and goat cheese labelling on the market of the Republic of Croatia. During the four years (2012-2016) of the research, 133 cheeses from retail supermarket chains were selected by the random-choice method by the responsible inspection of the Republic of Croatia and analysed at the Reference Laboratory for Milk and Dairy Products of the Department of Dairy Science at the Faculty of Agriculture University of Zagreb. To check the correct labelling of cheeses, the chemical composition of cheese was examined: the fat content, the dry matter content, the fat in dry matter content, and the water content in the fat-free cheese compound were calculated according to the Ordinance on Cheeses and Cheese Products, which refers to cheeses manufactured in the Republic of Croatia, and Regulation EU (2011) of the European Parliament and the Council on providing information to consumers about food products, which covers foreign cheeses. The presence of cow milk in cheeses labelled as products manufactured exclusively from ewe or goat milk was tested by the reference method using iso-electric focusing to determine any adulteration according to Commission Regulation (2008). The results of analysis in this research show the condition of the quality and correct labelling of ewe and goat cheeses on the market of the Republic of Croatia. Of the 133 cheeses analysed, 67 cheeses (50%) did not correspond to the values stated on the declaration or to legal regulations, while the presence of cow milk was found in 30% of the cheeses analysed. The research results indicate the need to carry out continuous systematic control in the interest of protecting consumers and those manufacturers who are following good manufacturing practices.

Keywords

Labelling and Adulteration of Cheese, Cow Milk, Ewe Milk, Goat Milk

1. Introduction

Milk and dairy products represent an important group of foodstuffs in planning a proper diet for the normal growth and development of the human organism and for preserving its health. The high nutritive values of milk and dairy products have led to a high demand that is increasing daily. However, higher demand has made this group of foods susceptible to unfair manufacturing practices, specifically potential adulteration to obtain greater financial profits. The adulteration of milk and dairy products is one of the serious and growing problems facing the dairy industry. In addition to causing huge financial losses, it also represents a significant risk to human health [1]. The way of labelling should not deceive a consumer about a food's characteristics, in particular its nature, identity, composition, quantity, shelf life, origin and manufacturing procedures. Food marketed in the Republic of Croatia must be labelled, advertised and presented according to the provisions of the Food Act [2] and Regulation (EU) of the European Parliament and the Council [3] on providing information about the food for consumers and other regulations on food that permit consumers to be informed when choosing the food they use and to prevent them from being deceived [4].

Today, the frequently used expression "from a farm to a table" means the traceability and authenticity of products placed on the market, from raw material to consumption. The mixing of various types of milk is permitted by law, but a problem occurs when the final product is not correctly labelled. The adulteration of cheeses manufactured from ewe and goat milk by adding cheaper and more accessible cow milk, whose share has not been indicated on the product declaration primarily to achieve a greater profit on the final product, is one of the main problems in cheese making. In addition to effecting a change in organoleptic characteristics, cheese adulteration also changes the quality of a finished product, calling into question its safety against intolerance while deceiving consumers [2].

Since ewe, goat and cow milk proteins differ in their physical and chemical characteristics and (thermo)stability, depending on the technological manufacturing method, the identification of the type and share of milk from which cheese is manufactured is not always simple [5]. One of the most frequently used methods for proving cheese adulteration with other milk types is the electrophoretic method of protein separation by isoelectric focusing (IEF), which the European Commission adopted in 1992 as a referent method for proving cow casein in ewe, goat and buffalo cheeses [6]. A cheese sample, *i.e.* a product of ewe/goat milk is considered adulterated if it is determined to contain a level of both cow γ_2 - and γ_3 -caseins equal to or above the 1% reference standard level. A method to determine the adulteration of ewe and goat cheeses by adding cow milk has been successfully performed at the Reference Laboratory for Milk and Dairy Products of the Department of Dairy Science (RL) and was accredited in 2014 according to HRN EN ISO/IEC 17025 [7].

Until now, there has been no data in the literature on the correct labelling of

ewe and goat cheeses on the Croatian market. However, there are some examples from the scientific-professional literature of other countries, such as Iran [8] [9], Slovakia [10] [11], Brazil [12], Romania [13], the Czech Republic [14], Turkey [15], and Italy [16] in which labelling controls were carried out to determine dairy product adulteration from ewe and goat milk products through the addition of cow milk in order to protect consumers and harmonise the practise with legal regulations. However, data referring to the control of the proper labelling of the chemical composition of cheeses is still lacking.

The aim of this research was to examine the proper labelling of cheeses manufactured from ewe and goat milk on the Croatian market, to increase the competitiveness and to improve and promote the quality of domestic production. Samples from retail supermarket chains (133 cheeses) were selected by the random-choice method and analysed during the four-year research period (2012-2016).

2. Materials and Methods

2.1. Cheese Sampling

For this research inspectors from the State Inspectorate of Croatia (until January 2014) and after that inspectors from the Ministry of Agriculture collected and delivered cheese samples from retail supermarket chains using the random-choice method ensuring that the cheese samples were transported in portable refrigerators at a temperature of +4°C. Data on the product declarations were checked against the prescribed legal regulations [3] [17] [18] taking care of the origins of the manufactured cheeses.

2.2. The Analyses of Physical-Chemical Composition of Cheese

In accordance with the Ordinance on Cheeses and Cheese Products [17] [18] and Regulation (EU) [3], the cheeses were systematically and continuously controlled during the research for the correct chemical composition stated on the product declaration: the milk fat in cheese by HRN EN ISO 1735 (2008) [20] and the dry matter in cheese by HRN EN ISO 5534 (2008) [21]. The content of fat in a dry matter and water content in the fat-free cheese compound were also calculated. In addition, the content of ewe, goat and cow milk was determined in cheese samples and possible adulteration was determined by a reference method of isoelectric focusing (Commission Regulation 2008) [6]. The determination of adulteration was based on distinguishing isoelectric points of cow γ_2/γ_3 -caseins in relation to isoelectric point values of certain ewe i.e. goat milk caseins. The method is comprised of the isolation of casein from cheese, isoelectric focusing of γ_2/γ_3 -caseins obtained by β -casein hydrolysis with plasmin, and semi-quantitative determination of cow, ewe and goat milk γ -caseins by densitometry [6] [22]. Physical-chemical analyses of the cheeses were carried out at the RL and accredited according to HRN EN ISO/IEC 17025 [7]. For statistical analysis the MS Excel (2007) program was used. The data were analysed using the descriptive statistic.

3. Results

According to the literature, most studies on the control of milk and dairy product safety by determining adulteration through the addition of cow milk have been conducted by using the polymerase chain reaction (PCR) method [8] [9] [10] [12] [14] [16] [23] and [24]. Liquid chromatography in combination with mass spectrometry (LC/MS) [25] and immunological methods have also been used [11] [13] and [15].

In this research cheeses with a known composition of cow and ewe, or cow and goat, milk with 0%, 0.5%, 1%, 2%, 5%, 10%, 25%, 50%, 75% and 100% (v/v) cow milk were used to obtain the most reliable results and to determine the content of cow, ewe and goat milk in cheeses of an unknown composition. This quantification was carried out by determining the relationship of peak areas of cow γ -caseins compared to ewe/goat γ -caseins in prepared cheese using a densitometric evaluation of gels [22]. At the same time, samples of unknown composition were analysed on the same gel with cheeses of a known composition and reference BCR-599 standards (0% and 1% of cow milk). Calibration curves of the relationship between the peak areas of cow γ -caseins (calculated as a percentage of total γ -casein) versus the relative percentage of cow milk in the composition were prepared for cheeses of a known composition (Figure 1 and Figure 2). The calibration curves that were obtained were used for calculating semi-quantitative content of cow milk in all of the analysed samples.

During the research, 133 cheese samples selected by the random-choice

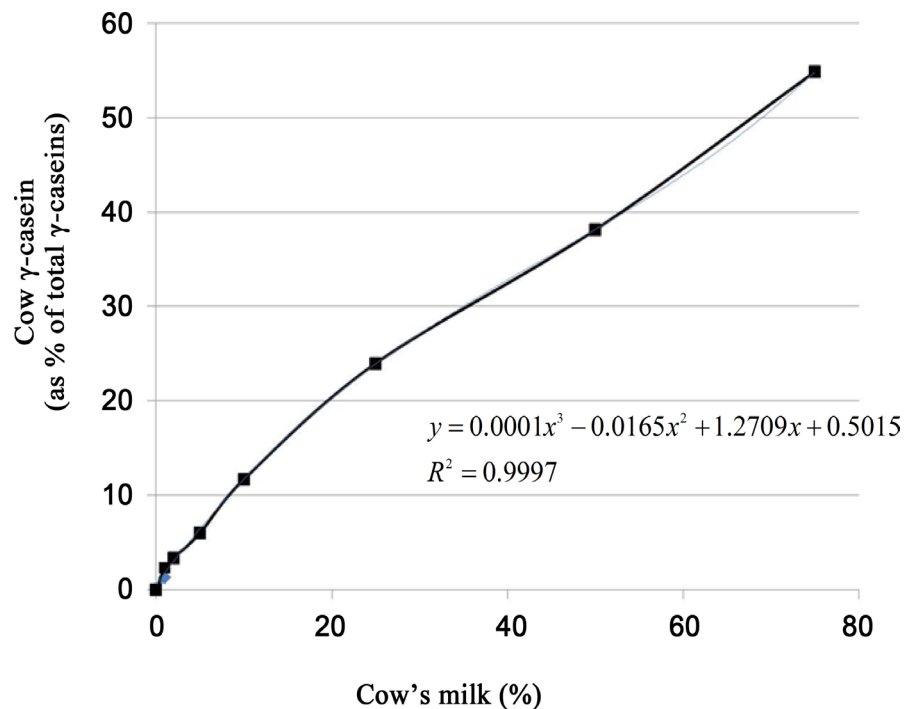


Figure 1. Calibration curve represents the content of cow γ -casein (expressed as % of total γ -casein) in contrast to the relative % of cow milk in prepared cheeses of a known composition of cow-ewe milk (■). The Reference standards BCR-599 of 0% and 1% cow milk (◆).

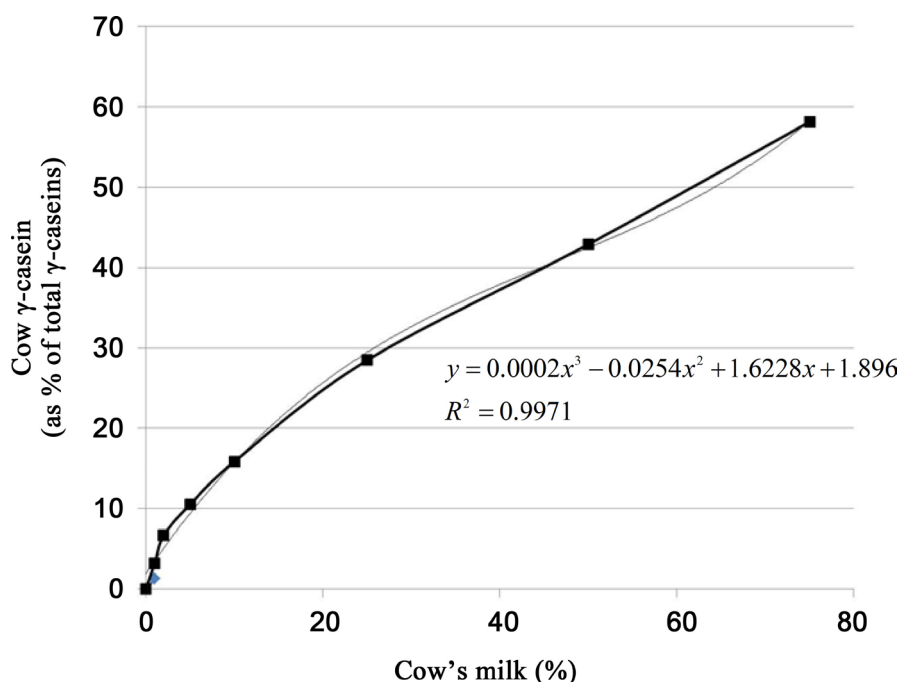


Figure 2. Calibration curve represents the content of cow γ -casein (expressed as % of total γ -casein) in contrast to the relative % of cow milk in prepared cheeses of a known composition of cow-goat milk (■). The Reference standards BCR-599 of 0 and 1% cow milk (◆).

method from retail supermarket chains were analysed (**Tables 1(a)-(c)**). According to legal national regulation [17] all cheeses produced in Croatia should be marketed under the names: refer to the water content in the fat free cheese compound: extra-hard (<51%); hard (49% - 56%); semi-hard (54% - 69%); soft (>67%) and fresh cheese (69% - 85%). For cheeses produced in EU countries verification of declaration is made in accordance with Regulation EU (2011) of the European Parliament and the Council [3].

The research itself, i.e. the control of correct cheese labelling, can be divided into two stages. The first stage refers to the duration of the project from 2012 to 2014 entitled “*Quality Control of Cheeses on the Market to Increase Competitiveness*” during which 73 cheese samples were analysed, 55 of which were manufactured in Croatia, 17 in EU countries and 1 in the Republic of Serbia (**Table 2**).

The analyses for controlling the correct chemical composition stated on the product declaration provided the following results on the quality and correctness of cheeses manufactured from ewe and goat milk on the Croatian market. Of the 33 samples of ewe cheeses, only 9 (27%) samples analysed completely complied with the requirements under the Ordinance on Cheeses and Cheese Products [17] [18] [19] and Regulation (EU) [3], while the remaining 24 samples (73%) did not comply with those requirements.

Of the 40 goat cheeses that were analysed, 11 (28%) completely complied with the requirements of the Ordinance on Cheeses and Cheese Products [17] [18] [19] and Regulation (EU) [3], while the remaining 29 (72%) did not comply. The

Table 1. (a) The results of chemical composition and γ_2/γ_3 cow caseins of ewe cheeses on the market of Croatia; (b) The results of chemical composition and γ_2/γ_3 cow caseins of goat cheeses on the market of Croatia; (c) The conditions of proper labelling of ewe and goat cheeses on the market of Croatia.

(a)

No.	The dry matter content (%)	The water content in the fat free cheese compound (%)	γ_2/γ_3 cow caseins (%)	No.	The dry matter content (%)	The water content in the fat free cheese compound (%)	γ_2/γ_3 cow caseins (%)
Ewe cheeses							
1	74.39	44.77	10.70	34	67.11	51.68	0.00
2	75.24	41.38	0.66	35	68.29	50.49	0.00
3	70.69	43.81	52.79	36	45.74	70.23	0.00
4	77.27	39.03	16.29	37	64.21	55.69	0.00
5	45.68	74.16	0.00	38	65.82	54.14	1.91
6	60.99	57.91	10.40	39	68.78	51.76	1.20
7	71.80	42.80	0.00	40	67.24	50.02	0.00
8	69.65	49.37	0.00	41	60.40	57.79	1.35
9	51.49	64.02	0.00	42	69.79	49.91	1.14
10	74.61	45.59	11.66	43	68.08	49.02	8.61
11	73.86	45.46	11.41	44	57.90	57.35	0.70
12	71.68	37.75	0.00	45	62.01	56.55	22.48
13	74.91	44.15	7.96	46	70.82	47.67	0.00
14	58.84	58.17	0.00	47	67.61	51.02	0.67
15	63.52	54.50	0.00	48	60.30	57.40	13.10
16	72.95	46.03	0.00	49	67.38	50.91	1.07
17	73.45	45.42	0.00	50	69.37	47.15	0.87
18	73.89	44.23	14.43	51	48.23	67.60	0.00
19	70.26	48.18	0.51	52	77.86	38.55	0.00
20	79.57	35.85	26.45	53	40.90	66.76	0.00
21	70.74	44.00	0.91	54	67.09	49.85	0.00
22	80.83	34.40	0.00	55	72.58	45.41	2.48
23	70.15	47.06	56.26	56	73.88	42.20	0.91
24	67.85	50.32	2.15	57	68.92	50.54	1.68
25	61.89	52.61	0.00	58	63.90	56.35	2.03
26	55.40	58.35	0.00	59	73.61	42.76	1.02
27	67.39	49.42	0.00	60	55.19	73.59	1.02
28	68.74	47.92	0.00	61	66.27	49.35	1.23
29	67.72	49.31	2.03	62	60.36	59.48	8.33
30	68.32	49.04	27.11	63	38.48	49.14	5.14
31	66.79	49.49	1.41	64	65.19	54.55	1.11
32	66.49	50.18	1.45	65	64.28	54.58	1.39
33	79.66	34.32	8.56	-	-	-	-

*Results shadowed in gray are not in accordance with Regulation (EU) [3] and Ordinance [17] [18].

(b)

No.	The dry matter content (%)	The water content in the fat free cheese compound (%)	γ_2/γ_3 cow caseins (%)	No.	The dry matter content (%)	The water content in the fat free cheese compound (%)	γ_2/γ_3 cow caseins (%)
Goat cheeses							
1	63.47	56.15	0.00	35	47.35	67.59	43.31
2	59.94	52.26	17.55	36	41.03	75.66	72.72
3	68.86	51.26	0.00	37	55.71	60.95	65.67
4	72.46	41.09	17.88	38	64.28	56.03	7.25
5	63.24	55.44	0.00	39	26.94	81.26	96.10
6	48.70	66.17	0.00	40	67.69	52.26	1.18
7	93.31	11.91	18.75	41	60.92	61.10	0.00
8	71.13	46.35	12.98	42	57.50	59.05	1.17
9	50.54	69.47	24.16	43	49.57	68.31	0.97
10	57.47	59.05	8.11	44	59.37	61.26	0.00
11	55.63	59.32	42.33	45	63.19	55.88	0.00
12	54.78	62.67	91.17	46	55.22	54.29	2.00
13	39.10	72.83	0.64	47	58.52	57.35	1.34
14	51.22	66.98	0.61	48	59.03	56.27	0.00
15	48.85	65.64	0.00	49	54.45	64.64	7.79
16	46.42	67.85	1.29	50	57.45	58.79	15.98
17	53.51	62.86	0.81	51	72.14	44.21	0.00
18	41.59	71.88	0.54	52	59.44	57.52	18.84
19	55.60	60.06	0.00	53	58.28	56.77	1.65
20	47.33	67.21	0.00	54	47.57	71.21	4.97
21	49.60	66.39	0.00	55	49.18	66.64	9.04
22	60.22	55.20	0.80	56	51.32	65.05	1.81
23	60.00	57.13	0.00	57	57.58	60.70	0.49
24	57.12	57.72	8.57	58	51.20	65.42	0.00
25	62.08	57.67	0.00	59	50.62	64.02	0.51
26	55.98	48.36	14.95	60	60.42	62.36	0.33
27	62.33	56.88	0.00	61	58.11	59.14	1.69
28	67.46	50.08	0.22	62	59.22	58.17	5.33
29	55.58	59.24	0.84	63	48.64	64.76	12.71
30	64.10	52.43	1.90	64	55.04	63.66	0.02
31	53.13	63.24	0.00	65	57.27	60.80	2.86
32	82.09	30.38	0.00	66	62.14	55.46	0.21
33	62.09	56.37	0.00	67	58.79	56.73	2.46
34	54.81	60.28	0.00	68	60.78	58.57	5.95

*Results shadowed in gray are not in accordance with Regulation (EU) [3] and Ordinance [17] [18].

(c)

Country of origin	Number of cheeses	Ewe cheese	Goat cheese	Number of cheese which DO NOT comply with legal regulations*		Number of adulterated cheeses	
				Ewe	Goat	Ewe	Goat
Croatia	95	47	48	23	28	16	16
EU	37	18	19	8	8	3	6
Serbia	1	-	1	-	-	-	-
Σ	133	65	68	31	36	19	22

*Regulation (EU) [3] and Ordinance [17] [18]; Σ—sum of all samples in the column.

Table 2. Control of cheese labelling on the market of the Republic of Croatia.

Country of origin	Number of cheeses	Ewe cheese	Goat cheese	Number of cheese which DO NOT comply with legal regulations*		Number of adulterated cheeses	
				Ewe	Goat	Ewe	Goat
Stage I The Project 2012-2014							
Croatia	55	24	31	18	24	11	11
EU	17	9	8	6	5	1	3
Serbia	1	-	1	-	-	-	-
Σ	73	33	40	24	29	12	14
Stage II 2015							
Croatia	24	12	12	2	3	3	4
EU	11	5	6	1	3	1	1
Σ	35	17	18	3	6	4	5
2016							
Croatia	17	12	5	3	-	2	-
EU	8	2	6	1	1	1	3
Σ	25	14	11	4	1	3	3

*Regulation (EU) [3] and Ordinance [17] [18]; Σ—sum of all samples in the column.

overall results obtained from these analyses showed that of the 73 cheese samples that were analysed, 73% did not comply with the Ordinance on Cheeses and Cheese Products [17] [18] and Regulation (EU) [3], *i.e.* they did not comply with values stated on the declaration [19].

Cheeses manufactured in Croatia (55) were analysed by the isoelectric focusing reference method. Adulteration, *i.e.* the presence of cow milk, was detected in 22 samples (40%). Also, 17 cheeses from EU countries were analysed. Adulteration was detected in 4 cheese samples (24%). The presence of cow milk was not detected in the cheese sample from the Republic of Serbia. From these results of the analysed cheese samples, stated as cheeses from ewe or goat milk, we

can conclude that the presence of cow milk was detected in 40% of the total number of samples of Croatian origin, and in 24% of the total number of samples of foreign origin.

Furthermore, of the 33 cheeses declared as ewe cheese, the results of the analyses showed the presence of cow milk in 12 (36%), while of the 40 cheeses declared as being made from goat milk, adulteration was indicated in 14 (35%). These results show that the addition of cow milk in the production of cheeses from ewe and goat milk is equally present, 36% and 35%, and is not a rare occurrence.

The results of these analyses for controlling the correct labelling on the declaration of ewe and goat cheeses do not present an image of quality products that comply with the prescribed legal regulations. To the contrary, they indicate the need for counselling and education of domestic manufacturers as was done during the first research stage (2012-2014), and the need for further control of correct labelling of the ewe and goat cheese on the Croatian market. Manufacturers of cheeses showed great interest in application of recommendations and improvement of production technology. Manufacturers of cheeses covered by this research within the project responded positively, and they have expected advantages from those products that do not comply with quality, structure and manner of labeling.

In Stage II of the research, which included further cooperation of the Faculty of Agriculture University of Zagreb and the Ministry of Agriculture of the Republic of Croatia, an additional 35 samples in 2015 and 25 samples in 2016 were tested and analysed (**Table 2**). Although the number of samples has decreased each year, the results obtained have shown improvement in the quality of cheeses produced from ewe and goat milk of Croatian origin, *i.e.* there is a decreasing trend of products that do not comply with the requirements of the Ordinance on Cheeses and Cheese Products [17] [18] [19] and Regulation (EU) [3] on providing food information to consumers, whose implementation has been ensured by the Provision of Food Information to Consumers Act [2] [26]. Of the 35 cheese samples analysed in 2015, 26% did not comply with regulations which, compared to the beginning of the project, represents an improvement of 47%. At the same time, the presence of cow milk, *i.e.* adulteration, was detected in 29% of analysed cheeses of Croatian origin, which represents an improvement of 11% compared to Stage I. In addition, the decreasing trend of products that do not comply with legal regulations continued in 2016, when 25 ewe and goat cheeses were sampled and analysed. Of that number, 24% did not comply with the prescribed legal regulations, while the presence of cow milk, *i.e.* adulteration, was present in 24% of the cheeses.

During the research on correct labelling of ewe and goat cheese on the market of Croatia, 133 samples of ewe and goat milk were analysed, 67 cheeses (50%) of which did not comply with the Ordinance on Cheeses and Cheese Products [17] [18] [19] and Regulation (EU) [3], while adulteration was determined in 41 (31%) cheeses (**Table 2**).

In Stage I of the research have been detected all cases of adulteration of cheeses that we ranked according to determined content of cow milk: less than 1% (not adulterated); from 1% to 5%; >5% to 20%; >20% to 50% and >50%. In the cases of adulteration from 1% to 5% added cow milk can be considered that this were an accidental adulteration that may have occurred because of the ignorance of manufacturers. As a positive result from this research arises the fact that during the Stage II adulteration cases of cheeses were absent by the addition of 20% to 50% and more than 50% of cows' milk (**Table 3**).

4. Discussion

From the available literature there are cases involving the adulteration of dairy products, such as ewe and goat milk cheeses by adding cheaper cow milk, the addition of which is not indicated on a declaration, are rather frequent. Many countries carry out the labelling control of cheeses manufactured from ewe and goat milk to determine the level of adulteration. For instance, an analysis carried out in Iran examined 105 dairy products labelled as ewe milk products. The presence of cow milk, which was not indicated on the product declaration, was established in 77% of products [8]. Other research has confirmed adulteration with cow milk in more than 70% of analysed yoghurt samples and 80% of analysed cheeses manufactured from sheep milk [9]. Research for controlling correct labelling was also carried out in Italy, where the presence of cow milk was detected in 22 of the 30 samples of mozzarella cheese that were analysed [16]. In Austria, while controlling imported buffalo cheese market, adulteration was detected in three of the 18 (17%) samples that were analysed [25]. The presence of cow milk was determined in 67.3% of ewe and 79.7% goat cheeses in retail supermarket chains in Romania [13]. A similarly high percentage of adulteration (48%) was detected in cheese control carried out in Turkey [15]. The presence of cow milk was detected in 4 out of 24 analysed cheeses in a study to determine adulteration of goat and ewe cheese of EU origin from retail supermarket chains in the Czech Republic [14]. According to Zelenakova *et al.* [10] the presence of cow milk was detected in 12 cheese samples (40%) of the 30 analysed ewe cheeses, while of the total of 70 analysed dairy products manufactured from

Table 3. Determined percentage of added cow's milk in sheep and goat cheeses during the four years (2012-2016) of the research.

Stage of research	The addition of cow's milk (%)				
	<1*	≥1 - 5	>5 - 20	>20 - 50	>50
Stage I**					
2012-2014	46	5	11	3	8
Stage II					
2015	27	3	5	-	-
2016	20	2	3	-	-

*Not adulterated according to Commission Regulation (2008) [6]; **[19].

ewe milk, adulteration was determined in 20 samples (29%). Furthermore, in the control of local manufacturers of fresh goat cheeses who sell their products via retail in Brazil, adulteration was determined in all 20 analysed cheeses [12].

The results obtained in this research are unacceptable and indicate the importance of quality control and labelling of food products. A positive trend in the decreasing the number of cheeses that do not comply with the prescribed legal regulations and a decreasing trend in adulteration have been one result of a four-year effort and cooperation between the Faculty of Agriculture of the University in Zagreb and the Ministry of Agriculture of the Republic of Croatia to harmonise the Croatian market with European agricultural policy, international markets and legal regulations and finally, to protect consumers.

5. Conclusions

Cheeses manufactured from ewe or goat milk have special characteristics (value of ingredients, organoleptic features, and technological production processes) and they have a higher value for consumers. For this reason, such products should be subjected to systematic control (for example, once a year) by authorised inspection organizations to determine their quality, price and competitiveness. The purpose of such a control would be to determine if a product, in this case cheese, complies with the prescribed legal regulations—the Food Act, Ordinance on Cheeses and Cheese Products [2] [17] [18] [19], Regulation (EU) [3]—and whether it matches the specific characteristics described on the product declaration. In addition, food manufacturers should also establish a good quality control system to ensure safe practices for the production of food products for human consumption and nutrition.

It can be expected that systematic product control will lead to increased trust among consumers, to the prevention of deception in the food business and to an improvement in the correct labelling of food products. It can also be expected that domestic products would then be on the same level as products from the international market, and that they would have an advantage against products that do not match their quality, composition and labelling requirements.

It can be expected that this research will increase manufacturer awareness of the need for correctness in labelling products, thereby leading to an improvement in the quality of Croatian products, in these particular case cheeses.

This four-year research on the systematic control of labelling of ewe and goat milk cheeses on the market of the Republic of Croatia is a significant contribution to ensuring fair practices in the food (cheese) trade and to encouraging better adjustment to the demands of the domestic and EU markets. The final conclusion of this research is that there is a need for continuous and systematic monitoring of dairy products (cheeses) placed on the market of the Republic of Croatia.

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