

# Consumer's attitude and manipulation of raw milk from milk vending machines

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## ABSTRACT

Despite the high nutrition level of raw milk, consumption of it poses a health risk for consumers, especially high-risk populations. The aim of this survey was to determine consumer's attitude towards raw milk from milk vending machines (n = 305) and to investigate their habits in manipulation of raw milk from the time of purchase until consumption (n = 74). Survey results show that the majority of consumers purchases milk once a week, using their own glass bottle and consume the milk in approximately two days. In most cases, consumers transport milk to their homes in less than 15 minutes without the use of a cooler bag. The manner of bottle cleaning technique depends on bottle material. Almost half of the consumers boil milk before consumption, which is associated with their attitude towards the safety of raw milk consumption. Most of them are satisfied with the level of hygiene on milk vending machines. The majority of consumers is unfamiliar with health risks of raw milk consumption and correct usage.

**Key words:** raw milk, milk vending machines, consumer's attitude, manipulation, food safety

Received: 12.12.2014

Accepted: 2.2.2015

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## INTRODUCTION

Milk represents one of the basic foods in the human nutrition for all age groups, for it contains a high level of nutrients with wide spectrum of proteins, minerals, calcium, phosphate, essential amino acids, especially lysine and vitamins B2 and B12 [1-3]. It is scientifically proven that milk and dairy products positively affect development and function of the gastrointestinal tract and the immune system, growth and function of microbiota, which also includes probiotic function [4]. High level of calcium has an important role in development, firmness and solidity of bones in childhood and adolescence and in maintenance of bone mass in adulthood [1, 4]. In combination with other nutrients in milk calcium also modulates adipocyte metabolism of lipids [4]. Lactose, as the main carbohydrate in milk, has a low glycemic index and at the same time speeds up the absorption of calcium and magnesium [3].

Raw milk is a high quality food with a high nutrition level [1-3], but it is important to be mindful of the health risks that consumption of raw milk poses, of which World Health organization (WHO) and other government organizations also alert [2, 5]. Consumption of raw milk poses a risk for infection with *Listeria monocytogenes*, *Coxiella burnetii* (Q fever), *Campylobacter jejuni* and *coli*, *Salmonella* spp., enteropathogenic *Escherichia coli* (EPEC) and enterotoxigenic (ETEC) *E. coli*, *Yersinia enterocolitica*, *Staphylococcus aureus*, etc [3, 6]. Pathogenic microorganisms can cause health problems to any consumer, but especially to young children, pregnant women, elderly, chronically ill and immunodeficient people. Pregnant women are an especially vulnerable population, for infection with *Listeria monocytogenes*, which can be found in raw milk, poses a danger to the embryo, fetus and infant (abortion, stillbirth and neonatal death) [6, 7].

It is recommended to boil the milk to kill pathogenic microorganisms, particularly if the milk is being consumed by a member of a high risk health group [7]. European regulative defines the criteria for hygiene of raw milk: plate count number at 30 °C  $\leq$  100.000 cfu/mL and somatic cell count  $\leq$  400.000 cfu/mL [8].

Raw milk vending machine is an automatic dispensing system and is usually positioned in a place with high frequency of passers-by. Vending machines have been used in Slovenia since 2010. They are operated by farmers who are also producers of the milk being sold. Normally a vending machine is being refilled once a day. Hygienic suitability of the milk and of the vending machine are responsibilities of the owner. The temperature of raw milk must be regulated and must not exceed 4 °C, the temperature must be displayed on a vending machine for consumer's knowledge. Raw milk can be poured in consumer's own bottles or in the bottles purchased in a vending machine located in its vicinity [2].

Past microbiological analyses of raw milk from vending machines showed that milk was not always hygienically adequate, as shown by increased plate count number [9-13] and increased somatic cell count [13, 14]. Consumption of raw milk from a vending machine also poses a chemical hazard [15]. These deviations show a potential hygienic risk of raw milk consumption [9, 13].

To ensure a safe consumption it is important to implement a good hygiene, farming and manufacturing practice, elements of which are presented and defined in European regulations [8, 16]. The elements of good practices are: hygiene-technic requirements (holdings, premises and equipment), maintaining the hygiene level during milking, collection and transportation of milk, handling of waste milk, control of pests and staff hygiene, etc. [8, 16]. For a better detection and prevention of hazards an owner must provide a control system over critical control points with the HACCP system (Hazard analysis and critical control point) [16, 17]. Health unsuitability of raw milk is usually a consequence of poor hygiene circumstances and human sloth [18-21]. For example, it is of a great importance to strictly maintain the cold chain of raw milk before the consumption as this is the only way to prevent excessive bacterial growth; the number of microorganisms at 21 °C doubles in one hour [22].

In Europe the highest part (39.7 %) of food poisoning occurs in households. Most foodborne illnesses caused by raw milk consumption are due to infections with *Campylobacter* spp. In 2012 as high as 20.0 % of all *Campylobacter* infections were caused by milk consumption, one year before, in 2011 quota of this infections was assessed as 13.5 % [23]. Campylobacteriosis was the zoonosis with the highest number of human confirmed cases in 2012 [23].

The aim of this study was to investigate consumer's attitude towards raw milk from milk vending machines and their habits and handling in milk manipulation from the time of purchase until usage.

## METHODS

This cross-sectional study about consumer's attitude and manipulation of raw milk from milk vending machines was conducted from November 2013 to February 2015 in Municipality Ljubljana – the capital of the Republic of Slovenia.

Data was collected on weekday mornings and afternoons. There were 305 random passers-by and 74 random consumers of milk from milk vending machines included in the survey. Gender and age of respondents were controlled to ensure a balanced randomized sample. All surveys were conducted by two trained interviewers.

This study is divided into two sections: (1) consumer's attitude towards raw milk from milk vending machines and (2) consumer's manipulation of raw milk from milk vending machines.

### Questionnaire design

Questions were both open- and close-ended. The questionnaire consisted of demographic questions (gender, age and place of residence), seven questions about consumer's attitude towards raw milk from milk vending machines and 20 questions about manipulation of raw milk from milk vending machines.

The first part of questionnaire (demographic characteristics and consumer's attitude towards raw milk from milk vending machines) was completed by both those who purchase and those who do not purchase raw milk from milk vending machines. The second part of questionnaire (manipulation of raw milk from milk vending machines) was completed only by those who purchase raw milk from milk vending machines. The first part of questionnaire took approximately three minutes to complete and the second part took between five to ten minutes to complete.

The questionnaire was pilot tested by 20 participants in October 2013 to confirm question clarity, identify response options, and gauge likely interview duration. The questionnaire was revised on the basis of pre-test results and other recommendations.

### **Data analysis**

#### **Quantitative analysis**

The questionnaire responses were statistically analysed with SPSS Statistics 21.0 (IBM ®). Mean responses with standard deviation and percentages of responses in each category were calculated and presented in tabular form. To examine the relationship between variables, cross-tabulation and  $\chi^2$  test were used.

#### **Qualitative analysis**

Qualitative analysis was used to evaluate the responses of three open-ended questions. Consumer's responses were displayed as codes, which were categorized in categories [24].

For analysing the open questions "Why do you decide or not decide for the purchase of raw milk from a vending milk machine?" and "What should be changed in the offer of milk vending machine?" we used the description method based on qualitative content analysis [25, 26], which is based upon grounded theory [27]. This methodology helped us determine respondent's motivation for the purchase of raw milk from vending milk machines. Validity of the interpretation is justified by the expert triangulation. Three researches of different expert pre-knowledge and research experiences were included in the interpretation. The basis for the qualitative content analysis represented the transcripts of the answers to the mentioned question. The answers were suitably marked and a numbers of individual questionnaires were added to the research code (CFS). The content analysis was started by assigning the codes to the major topics. The codes were assigned to individual statements or parts of the statements accordingly to repeated reading of the answers. Codes were grouped in thematic categories. The categories and the codes had been upgraded until the majority of the respondent's statements could be organized.

## RESULTS AND DISCUSSION

### Consumers attitude towards raw milk from milk vending machines

There were 305 completed questionnaires. Demographic features of survey participants are presented in **Table 1**. The percentage of genders was almost equal; the largest group of participants were 26 to 55 years old inhabitants of Ljubljana (27.2 %).

Questioning took place in shopping centres (54.1 %) and on the streets (45.9 %) of Ljubljana. Raw milk from milk vending machines was reported by 21.3 % of respondents, 9.2 % buy milk directly from dairy farms and 69.5 % purchase milk in supermarkets. Before the milk vending machine marketing, in year 2006, the percentage of people who purchased milk in the supermarkets was higher (85.4 %) [28]. The proportion of people who purchase milk on vending machines did not vary regarding the location of questioning. Data on demographic characteristics of milk vending machine users and non-users are presented in **Table 2**.

**Table 1:** Demographic characteristics of respondents

Demographic characteristics (n <sup>a</sup> = 305)	n <sup>a</sup>	Proportion (%)
<b>Gender</b>		
Male	148	48.5
Female	157	51.5
<b>Age group</b>		
≤ 25 years	78	25.6
26-55 years	142	46.6
≥ 56 years	85	27.9
<b>Place of residence</b>		
City (Ljubljana)	172	56.4
Ljubljana suburbs	61	20.0
Other cities	72	23.6
<b>Location of questioning</b>		
Shopping centre	165	54.1
Streets, squares	140	45.9

<sup>a</sup> Number of respondents

**Table 2:** Demographic characteristics of respondents, regarding if they purchase raw milk on milk vending machines or not

Demographic characteristics (n <sup>a</sup> = 305)	Purchase raw milk (n <sup>a</sup> = 65)		Do not purchase raw milk (n <sup>a</sup> = 240)	
	n <sup>a</sup>	%	n <sup>a</sup>	%
<b>Gender</b>				
Male	31	10.2	117	38.4
Female	34	11.1	123	40.3
<b>Age group</b>				
≤ 25 years	14	4.6	64	21.0
26-55 years	37	12.1	105	34.4
≥ 56 years	14	4.6	71	23.3
<b>Place of residence</b>				
City (Ljubljana)	43	14.1	129	42.3
Ljubljana suburbs	11	3.6	50	16.4
Other cities	11	3.6	61	20.0
<b>Location of questioning</b>				
Shopping centre	32	10.5	133	43.6
Ljubljana streets	33	10.8	107	35.1

<sup>a</sup> Number of respondents

The majority of consumers who purchase milk on vending machines do so because they think that this milk is superior in quality (43.3 %) and healthier (20.0 %). The most prevalent reasons for not using milk vending machines are little or no milk consumption (27.8 %) and because milk is easier to purchase in supermarkets (16.1 %).

### Results of qualitative analysis

Consumers mostly purchase raw milk on milk vending machines because they are of an opinion that this milk is superior in quality and healthier, they trust in the milk origin, what they also like is that the raw milk vending machines are easily accessible and available at all times. Beside other, less represented causes consumers prefer this milk for its unprocessed characteristics. On the other hand, survey participants, who do not consume raw milk from milk vending machines, do not decide for this purchase because they do not like its organoleptic properties, raw milk duration, price, milk processing and inaccessibility of milk vending machines.

Others consume milk of a different origin and distrust in the milk itself. Further it is important to acknowledge that some survey participants, due to their health or their particulates in nutrition, consume little or no milk in general.

### Consumers habits regarding raw milk from milk vending machines

A total of 74 questionnaires were obtained. Demographic characteristics of participants are listed in **Table 3**.

More than a quarter of all analysed consumers purchase milk on vending machines once a week (28.4 %) or 3 to 5 times a week (27.0 %), which is comparable to study of Golčman [29], where it was discovered that 22.0 % of consumers purchase milk from vending machines once a week. Almost two thirds (60.8 %) of consumers buy 1 L of milk at a single purchase and one quarter (24.3 %) buys 2 L. Milk is being used in two days by 36.5 % and in three days by 31.1 % of consumers.

**Table 3:** Demographic characteristics of consumers that purchases raw milk on milk vending machines

Demographic characteristics (n <sup>a</sup> = 74)	n <sup>a</sup>	%
<b>Gender</b>		
Male	36	48.6
Female	38	51.4
<b>Age group</b>		
≤25 years	13	17.6
26-55 years	43	58.1
≥56 years	18	24.3
<b>Place of residence</b>		
City (Ljubljana)	51	68.9
Ljubljana suburbs	12	16.2
Other cities	11	14.9

<sup>a</sup> Number of respondents

The great majority (90.5 %) of consumers never check the temperature displayed on the vending machine and 91.9 % never use a cooler bag for transport. The reported time of transportation of raw milk from vending machine to respondent's homes is less than 15 minutes in 78.4 % of participants, 15 to 30 minutes in 14.9 % and over 30 minutes in 5.5 %; even among the latter group only 4.1 % use a cooler bag. The most probable reason why consumers do not use a cooler bag was already discovered in the study Jevšnik [28], where they found that 33.0 % of consumers think the use of a cooler is not needed and 51.7 % had never thought of a use of a cooler bag. Maintenance of cold chain during the transportation is important, for the temperature significantly influences generic time of microorganisms [6]. 91.9 % of consumers store milk in refrigerator, but in the study of Jevšnik [28] was concluded that more than two thirds of consumers (67.8 %) never check the temperature in the refrigerator and that the correct storing temperature (1-5 °C) is known to only 55.1 % of consumers.

Almost half of consumers (48.7 %) boil raw milk from a vending machine before consumption, 12.2 % boil it only occasionally. Organizations Food and Drug Administration, Centre for Disease Control and Prevention and National Institute of Public Health alert, that consumption of raw milk poses health risks [2], nevertheless 39.2 % of consumers still do not boil the milk before consumption. Boiling of milk is similar in all age groups (53.6 % of consumers aged 25 or younger, 50.0 % aged between 26 and 55 and 44.4 % aged 56 or more. On average raw milk from a vending machine is consumed by 3 people from one household (SD = 1,52). Milk is mostly used for preparation of drinks (66.0 %) or for cooking and baking (59.5 %). More detailed data of consumer's manipulation of raw milk from vending machines is displayed in **Table 4**.

**Table 4:** Habits of consumers of raw milk on milk vending machines

Query	Response	%
How often do you buy raw milk from milk vending machines? (n <sup>a</sup> = 74)	Every day	4.1
	3-5 times a week	27.0
	Once a week	28.4
	Less than once a week	13.5
	Once a month	17.6
	10 times or less in a year	5.4
	Till now I bought it 5 times or less	4.1
How much milk do you buy at a single purchase? (n <sup>a</sup> = 74)	0.1 L	4.1
	0.2 L	0.0
	0.5 L	4.1
	1 L	60.8
	2 L	24.3
	More than 2 L	6.8
Approximately how long does it take you to use milk from milk vending machines? (n <sup>a</sup> = 74)	1 day	13.5
	2 days	36.5
	3 days	31.1
	More than 3 days	18.9
Do you check the temperature of raw milk, which is displayed on milk vending machine? (n <sup>a</sup> = 74)	Yes	8.1
	No	90.5
	Occasionally	1.4
How much time does it take you to transport the milk home? (n <sup>a</sup> = 73)	≤15 minutes	78.4
	15-30 minutes	14.9
	30-60 minutes	1.4
	60-120 minutes	2.7
	≥120 minutes	1.4
Do you use a cooler bag for transportation of milk? (n <sup>a</sup> = 73)	Always	0.0
	Never	91.9
	Only in the summer	2.7
	Occasionally	4.1
Where/how do you keep the milk at home? (n <sup>a</sup> = 74)	In the refrigerator	91.9
	At standard temperature	7.0
	In the cellar	1.6
Do you boil milk before usage? (n <sup>a</sup> = 74)	Yes	48.7
	No	39.2
	Occasionally	12.2
For what purposes do you use raw milk from milk vending machine? (n <sup>a</sup> = 74)	Preparation of drinks	66.2
	Consumption of raw milk	31.1
	For cooking/baking	59.5
	For making fermented milk products	31.1

<sup>a</sup> Number of respondents



When purchasing raw milk from vending machines 70.3 % of consumers use their own bottle, and 29.7 % purchase bottles every time from a vending machines. At the beginning of raw milk from vending machines marketing, in 2010, half of the consumers used their bottle other half purchased the bottles on vending machines [29]. 52.7 % of consumers use glass bottles and 44.6 % plastic bottles. Plastic bottles are replaced at least once a month by 47.1 % of consumers and glass bottles by 19.3 %. Plastic bottle has never been changed by 5.9 % of consumers and glass bottle by 30.8 %. Consumers with their own glass bottle (37.1 %) and those with their own plastic bottle (45.0 %) mostly clean it with hot water and dish cleaner. Cleaning brush is being used more by those with glass bottle (37.2 %) than those with plastic bottle (10.0 %). The correct way to clean a bottle is to firstly flush it with warm water, secondly wash it with hot water and dish cleaner and in the end it should be again flushed with hot water. It is important to avoid hot water during first flush to prevent denaturation of milk proteins, because with the beginning colder flush we remove the most of the proteins of bottle wall without their denaturation, which can make the removal of proteins harder [30, 31]. The correct cleaning technique is being practiced by only 5.0 % of consumers who use plastic bottles and by none from the glass bottle users. The incorrect cleaning technique can enlarge the possibility of biofilm formation on the inside surface of bottles, which may represent higher health risks [32, 33].

More detailed data of the bottle type that is being used, frequency of bottle exchange and cleaning techniques is being displayed in **Table 5**.

While 73.0 % of participants are confident that raw milk consumption does not pose any risk for health, 17.4 % of participants think that consumption of raw milk does pose health risks and 9.6 % have no opinion on the subject. Opinion on safety of raw milk consumption between different age groups of participants shows that all aged 25 or younger, 69.8 % aged between 26 and 55 and 61.1 % aged 56 or older think that raw milk consumption do not pose a health risk. Overall milk is usually boiled by 75.0 % of those ( $n = 13$ ) who believe raw milk is a potential hazard for health and by 43.4 % of those ( $n = 54$ ) who think it is not. Boiling of raw milk is associated with the opinion that consumption of raw milk poses a health risk ( $\chi^2 = 6.77$ ;  $p = 0.034$ ).

Even though people trust in health and hygienic suitability of raw milk from a vending machine, previous studies have shown that raw milk from a vending machine is not always suitable for consumption. In the spring suitable plate count number has had 76.4 % [9] and 88.0 % of samples [10] and only 35.4 % of samples in the summer [9]. In the summer-autumn time suitable plate count number has had 60.0 % of samples [10], in the autumn 70.6 % [9] and in the winter 51.7 % of samples [11]. Hygienic suitability differs from one vending machine to another. In the previous study of Galičič et al. (2014) it was reported that 82.4 % measured central temperatures of raw milk exceeded 4 °C [9]. Slovene Consumer's Association has had also hygienically unsuitable results (54.5 %) regarding measured central temperatures of raw

**Table 5:** Respondent's answers regarding bottle type, frequency of bottle exchange and cleaning technique

Query	Response	%
What kind of packing do you use for milk? (n <sup>a</sup> = 74)	My own packing	70.3
	Packing I purchase at the vending machine	29.7
From what kind of material is your packing that you use? (n <sup>a</sup> = 74)	Plastic	44.6
	Glass	52.7
	Plastic or glass	2.7
How often do you change your own bottle? (n <sup>a</sup> = 26)	Once a week	0.0
	Twice a month	3.9
	Once a month	15.4
	Once on 2 months	7.7
	On 2-6 months	11.5
	Once every 6 months	11.5
	Once a year	7.7
	I don't change my bottle	30.8
	Other	11.5
How often do you change your own plastic bottle? (n <sup>a</sup> = 17)	Once a week	11.8
	Twice a month	17.6
	Once a month	17.6
	Once on 2 months	11.8
	On 2-6 months	11.8
	Once every 6 months	11.8
	Once a year	11.8
	I don't change my bottle	5.8
	Other	0.0
How do you clean your own bottle? (n <sup>a</sup> = 35)	Flushing with cold or warm water	2.9
	Flushing with hot water	2.9
	Washing with hot water and dish cleaner	37.1
	Washing with the brush, hot water and dish cleaner	22.9
	Washing with the brush and hot water	14.2
	Washing in the dishwasher	17.1
	First I flush it with warm water, than I wash it with hot water and dish cleaner and in the end I flush it again with hot water	2.9
How do you clean your own plastic bottle? (n <sup>a</sup> = 19)	Flushing with cold or warm water	5.3
	Flushing with hot water	21.1
	Washing with hot water and dish cleaner	47.2
	Washing with the brush, hot water and dish cleaner	5.3
	Washing with the brush and hot water	0.0
	Washing in the dishwasher	5.3
	First I flush it with warm water, than I wash it with hot water and dish cleaner and in the end I flush it again with hot water	5.3
	Other	10.5

<sup>a</sup> Number of respondents

milk [12]. It is proven that ambient air temperature and seasonality do not have an impact on hygienic suitability of raw milk from milk vending machines [9, 34]. Somatic cell count has also been found to be increased in raw milk [13, 14]. Residues of detergents in rinsing solutions of milk vending machines, which are being used for cleaning the chamber and the tube from which milk flows, were 21.7 % of them were found also the residues of detergents and disinfectants [15].

The majority of respondents (98.6 %) have never purchased spoiled raw milk from milk vending machine and the majority (97.3 %) is also satisfied with the level of vending machine hygiene. Mean assessment (Likert scale from 1 (poor hygiene level) to 5 (the highest hygiene level)) of hygiene of a vending machine filling chamber is 4.4 (SD = 0.7). Frece [14] came to the same conclusion in her study, where they discovered that appropriate level of hygiene of milk vending machines filling chambers has only 47.1 % of milk vending machines and 70.6 % of trash bins.

To 90.5 % of consumers the instructions for use of the milk vending machine seemed clear, while for 1.4 % they were not clear enough. 74.3 % of consumers were satisfied with the milk vending machine's offer. More detailed data on the subject of consumer's attitude towards raw milk from vending machines is presented in **Table 6**.

**Table 6:** Respondent's attitude towards raw milk from vending machines

Query	Response	n <sup>a</sup>	%
Do you think that consumption of raw milk poses a health risk? (n <sup>a</sup> = 74)	Yes	13	17.6
	No	54	72.0
	Does not know	7	9.4
Have you ever purchased rotten raw milk from milk vending machine? (n <sup>a</sup> = 72)	Yes	1	1.4
	No	71	98.6
Do you think the instructions for usage of the vending machine are clear enough? (n <sup>a</sup> = 74)	Yes	67	90.5
	No	1	1.4
	I have never read them	3	4.0
	I do not remember them	1	1.4
	I do not have an opinion	2	2.7
Are you satisfied with the level of hygiene of milk vending machines? (n <sup>a</sup> = 73)	Yes	71	97.2
	No	1	1.4
	Other	1	1.4
Do you think a change of offer available in the milk vending machines would be suitable? (n <sup>a</sup> = 74)	Yes	19	25.7
	No	55	74.3

<sup>a</sup> Number of respondents

Other consumers wish for additional products (ecological production, soured milk, quark, cheese, yoghurt, chocolate milk and other milk products), better accessibility, different milk origin, traceability throughout the process, higher level of hygiene of vending machines, price changes, additional instructions and information and improved technology of vending machines (calibration of milk dosage, lower position of the filling chamber).

## CONCLUSION

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With this cross-sectional study we have determined consumer's attitude towards the safety of raw milk consumption and have terminated consumer's manipulation with raw milk from the moment of purchase to the time of consumption at home. With this the purpose of this study has been achieved.

In general, consumers purchase raw milk from milk vending machines because they believe that this milk is of a superior quality and is healthier than processed milk available in the stores. Others do not decide for the purchase of raw milk from milk vending machines because they chiefly consume little or no milk. Consumer's manipulation of raw milk from vending machines shows consideration of the most basic food-safety principles, which concretely cover raw milk handling. On the other hand, concomitant elements are given less, most of the time not enough attention. When handling with raw milk from vending machines consumers consider the most basic recommendations of health organisations and also the fact that raw milk is a perishable food, it is especially well considered quick transport timing and correct milk storage, still not enough consumers boil raw milk before consumption. Consumers do not always act in accordance with good housekeeping practice [28]. In our research we found that they rarely use a cooler bag while raw milk transportation and they do not clean bottles efficiently.

In future, it would be important to educate consumers who purchase raw milk from vending machines of the correct way of manipulation of raw milk, as only a conscious consumer can become an active participant in food safety chain [28].

## LIMITATIONS OF THE STUDY

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For further researches and more representative results the location of this study should be extended to other regions. Closed-ended questions are another potential drawback because of the limited options for responses, this might have influenced some respondents to choose an answer they otherwise would not and as such does not necessarily represent a clear image of an average consumer of raw milk from vending machine. Regardless this design was essential for the statistical analyses, furthermore we have accomplished to wholly present consumer's attitude towards raw milk consumption and have as first in Slovenia analysed and presented consumers handling with raw milk from milk vending machines from the time of purchase to the time of consumption.

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