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# Hygienic Quality of Raw Cow Milk Produced by Smallholder Dairy Farmers in BeniMellelarea in Morocco

**Nadia Ferdous, RachidHnini, FatihaChigr, Mohamed Najimi**

***Abstract*—This study was conducted to evaluate the hygienic quality of raw cow milk produced by smallholder dairy farmers and cooperatives (collecting centers) in BeniMellal area in Morocco. Hygienic quality of milk was determined by assessing the analysis of Total mesophilic aerobic flora or Total Bacterial Count, Total Coliforms Count, Fecal coliforms count and fungi (Yeast and Molds). The objective of this study was to evaluate the global milk quality in Moroccan dairy herds (hygienic and pathogenic parameters) and the perspectives on dairy development.For this, we evaluated the variations in the overall quality of raw milk: bacteriological and hygienic characterizations. Thus, samples of raw cow's milk produced in 50 farms and cooperatives were selected from different geographical areas in BeniMellal region. The investigation has concerned different cattle farms with different breeding procedures. Taken altogether, the samples analyzed show a moderate to high level of contamination of raw milk during the four seasons investigated exceeding generally the accepted limits. The most contaminated samples were found during the warm seasons: spring and autumn. However small but encouraging load levels percentage is evidenced reflecting an effort in hygienic procedures for the collection of raw milk and its storage in conditions respecting hygiene and temperature. Concerning the high level contamination, for classical causes classical results. Indeed, transportation, milking and pre-storage conditions as well as climate constitute the main factors for heavy bacterial and fungal contamination Taken together these variations reflect essentially differences in practical breeding and milk collecting procedures.**

***Index Terms*—Raw cow milk, hygienic milk quality, microbiological load, BeniMellal,Morocco.**

## I. Introduction

Morocco has made great efforts in encouraging milk production principally cow milk. But if the produced amounts are in generally satisfactory, many problems related to the quality standards which are very hard to meet [1-6] still exist and is a real challenge for agro alimentary sector in the county. This, in general, is a result of the heterogeneity of raw milk's compositions due todifferent geographical areas and breeding practices[6-7] and could constitute in turn serious concern for human health [8].On the other hand, the hygienic quality of milk is of high importance for dairy industries. Indeed, in addition the final global quality of the raw milk destined to industrial processing (pasteurized or sterilized milk and other dairy products), the final cost of the processing its self could also be affected. So, it is essential to reduce the production costs and to face to this problem it is necessary to have a high quality milk or at least not with the worst one. For this, it is necessary to have the microbiological pattern of the collected dairy raw milk. Our previous studies have shown that raw cow milk produced in BeniMellal area display high variability among geographical subdivisions. In the present investigation, we use a novel approach to determine the overall of microbial loads of the entire raw cow milk produced in the large geographical area of BeniMellal. The results obtained will give an overall idea about the evolution of bacterial and fungi levels during seasons (winter, spring, summer and autumn).

**Nadia Ferdous,** Biological Engineering Laboratory, Faculty of Sciences and Techniques, Sultan MoulaySlimane University, BeniMellal, Morocco.
**Rachid Hnini,** Biological Engineering Laboratory, Faculty of Sciences and Techniques, Sultan MoulaySlimane University, BeniMellal, Morocco.
**Fatiha Chigr,** Biological Engineering Laboratory, Faculty of Sciences and Techniques, Sultan MoulaySlimane University, BeniMellal, Morocco.
**Mohamed Najimi,** Biological Engineering Laboratory, Faculty of Sciences and Techniques, Sultan MoulaySlimane University, BeniMellal, Morocco.

## II. Materiel and Methods

### A. Study area and data sources

**Studied area and study period**

This study BeniMellalarea situated in Tadla Plain in central of Morocco. The climate of the Tadla region is known to be semi-arid with a dry season from April to October and it is also characterized by a rainy season from November to March. The annual cumulative rainfall changes from 149 to 397 mm between 2000 and 2013 while the seasonal variations of temperature are significant with a maximum in August of 46 ◦C, a minimum in January of −6 ◦C and an annual average of 20 ◦C[9].The plain parts are well developed and the agriculture is generally based generally on irrigation methods. The study populations were raw cow's milk from milk collecting centers named also cooperatives of 50 different zones located in a zone of 40 km. The sampling points were principally milking buckets at farm level or transport containers. Just after receiving the raw milk in the cooperative, the samples are taken in sterile vials and transported directly to the laboratory in a cooler. The maximum time between sampling and the analysis of the samples did not exceed 2 hours. The samples was taken for four periods during the year: summer, autumn, winter and spring.

### B. Microbiological analysis

Dilutions of milk samples studied (in peptone water) varied from 10-1 to 10-7. The isolation and enumeration of

mesophilic aerobic flora, total coliforms, fecal coliforms, anaerobic sulphite-reducing bacteria, Staphyloccoccusaureus, yeasts and molds, were carried out according international standards[10].

Bacteria enumeration: for mesophilic aerobic flora, the non-selective culture medium Plate Count Agar (PCA) was used and the incubation conditions were 72h at 30°C. Then, the count of colonies was performed 24 and 48h. Concerning the enumeration of coliforms, we used the Desoxycholate Lactose Agar (DL, Oxoid, England), a selective medium for the detection of enterobacteriacea. The incubation was operated during 48h at 30°C to determine total coliforms or at 30°C for fecal coli forms. Only red colonies (lactose+) with a minimal diameter of 0.5 µm were considered. For the estimation of Salmonella, the Rappaport-Vassiliadis broth was used (24 h at 42°C) and Hektoen medium (24 h at 30°C). The confirmation of identification of suspect colonies was made by the aid of API20 E kit (Biomérieux, France). Finally for Listeria monocytogenes detection, we used broth Frazer (24 h at 37°C). The confirmation of suspect colonies was performed by the use of chromogenic medium with the API Listeria.

Enumeration of fungal flora: for this aim, we incubated selected samples in Dextrose Agar Medium (PDA, Merck, England) during 72 h at 25°C for yeasts and 6-7 days for molds.

## III. Results

The essential of results of the microbiological analysis of raw cow's milk produced in different areas representing BeniMellalregionare presented in Fig 1-5. The figures show the seasonal evolution of microbiological load (bacteria and fungi) in the raw milk samples analyzed. A first analysis shows the presence of different microbial loads amount in all the BeniMellal area. Thus, two strong points could be drawn from this analysis, variability in loads when a bacterial/fungi group is considered and when a season is also considered. Concerning total mesophilic florapresent in bulk-tank raw milk samples collected from the 50 farms and cooperatives investigated, the highly meanaverage % of bacteria is in the range of 106-107CFU ml-1 roughly from 48-53% during winter and summerto 60-65% during spring and autumn (Figure 1).This variability notably between winter-summer and spring-autumn could be attributed to the extreme temperatures recorded during the two first seasons and which are not favorable to bacterial growth in addition to a relatively low humidity level leading to a lesser percentagein contrast to the warm temperatures in addition to good hygrometryin autumn and spring explaining higher percentages (Afif et al., 2008). In accordance of these results, winter and spring display an average of 10% of bacterial load not exceeding 105 CFU ml-1.which could be considered as a good marker of respect of good milking practices and hygiene. In the other warm seasons, this proportion is significantly lesser (mean average of 3%). The remaining proportion is represented by the load ranged from 105to 106CFU ml-1(mean average: 30%). Interestingly, similar tendencyis observed for total coliforms concerning their seasonal variation (Figure 2). The most represented proportion of bacterial load is ranged from 104to 105CFU ml-1followed by the proportion of bacterial load ranged from 103to 104CFU ml-1The microbial analysis of fecal coliforms in raw cow milk samples show in generally the predominance of the proportion of bacterial load ranged from 104 to 105CFU ml-1along spring, summer and autumn seasons (average of percentage : 70%) whereas for winter the percentage is up to 49%.As a consequence, there is less variability in the distribution of higher and lower bacteria during the three first seasonsand more evidenced in winter (Figure 3).Concerning the other bacteria analyzed, we assessed the presence oflisteria monocytogenes, clostridium as well as salmonella sp but have not been able to detect them in all samples processed.

Concerning fungi, the loads calculated on the basis of individual bulk-tank milk samples for yeast show that the proportion of load ranged from 104 to 105 CFU ml-1 is represented at a range of 45%. A tendency in decreasing in load is observed from winter displaying the highest percentage (average of 58%), to autumn, displaying the lowest percentage load (about 32%; Figure 4). Surprisingly and exceptionally, the percentage of a microbial load exceeding 105 CFU ml-1is equivalent both in winter and in summer and represent an average of 25%, whereas in spring and winter, the average percentage is 50%. These results could probably be due to the factors cited above for TMF. Finally, when moldsare considered, a specific pattern is observed in that the microbial load of the proportion of 104-105 CFU ml-1 is predominant in general but more pronounced for spring and autumn seasons representing the 2/3 of the general load whereas they are in the range of 50% in winter and summer. By consequence, these later seasons display also an important percentage (average 40%) of microbial load in the low average level (up to 104CFU ml-1) compared to the other seasons (average 20%) (Figure5).

## IV. DISCUSSION

The aim of the present workwas to assess the hygienic quality of raw cow milk produced in the large geographical area of BeniMellal[11]. For this, we analyzed the microbiological characteristics (bacteria and fungi) of these samples.This microbiological evaluation is of high value of the quality of raw milk which is destined to be processed industrially (pasteurization or sterilization) and finally to master the quality of the finished product. In this study we analyzed the milk in a great geographical area around the Capital of the region i.e. BeniMellal to ensure that we respect the reality of milk collection destined to industry. The entire collection points and centers sale their milk to industries and by consequence, the microbiological analysis will give an idea on microbiological characteristics of milk originally destined to be processed as pasteurized milk essentially. For this, we pooled all samples and gave a radioscopy of their hygienic pattern. Taken together, the marked remark is the relatively high level of contamination both for bacteria and fungi.Concerning Total mesophilic aerobic flora and coliforms level evidenced in our raw milk samples is relatively high but still lesser than previous reports in raw cow milk in Morocco [1; 12-13].

The results of our study in the region of BeniMellal, show the presence of marked effect of seasonal factor on variations

of the microbial charge. We can resume this effect in two main periods, the first one is winter-summer characterized by extreme temperatures and low levels of humidity, conditions not in favor of the occurrence of high levels of bacteria and fungi. The second period is represented by spring-autumn seasons characterized by warm temperatures and a generous hygrometry which in turn is in favor of the presence of high levels of contamination. These could be due to the non-respecting of hygiene proceduresas during the pre-milking udder preparation and milk handlers, as well as during the storage operationsand transportation processes [14-15].The results obtained concerning fungi could explain at least partially the contamination of utensils or/and the contamination of working/storage environment.

Our results which are slightly different from those of Afif et al.[6]in the same area, show firstly that a positive evolution could be noticed and by consequence could be relevant for improving the general quality of fresh milk and particularly hygienic quality. But, this quality still remains quite low with reference to standards given by the authorities.

From a pathogenic point of view, the raw cow milk produced in BeniMellal area did not display anycontamination with Lisreriamonocytogenes nor with salmonella sp. This is in the line of our previous findings, not reporting on such contamination in other geographical zones of milk collection [5,6]. Previous studies in other areas in Morocco have not reported any contamination in collected raw milk [2]and [13]. .

## V. CONCLUSION

Although positive signals could be recorded from our investigation, the overall quality of milk produced in BeniMellal area did not meet hygienic standard quality and improvements have to be made.

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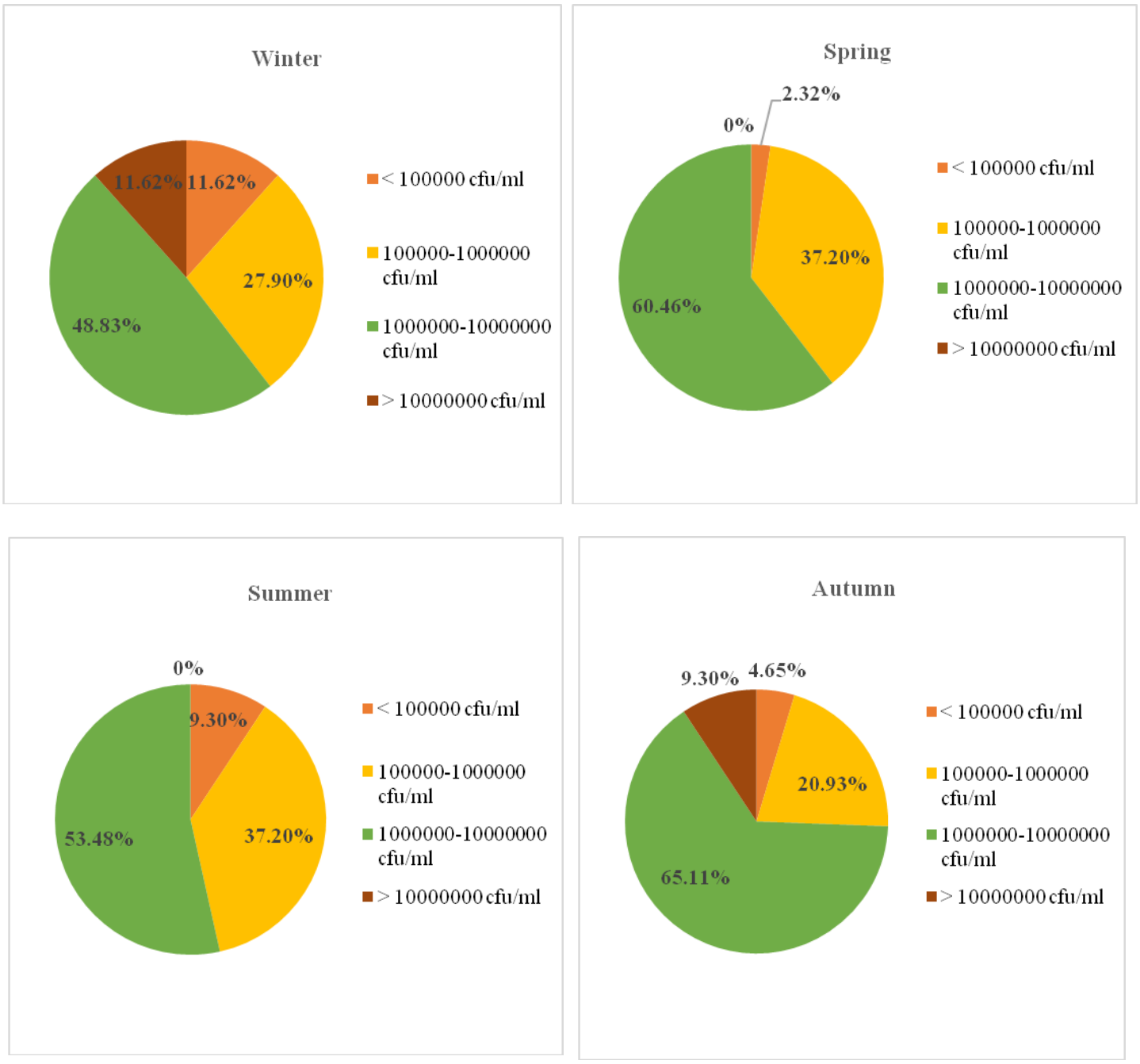


**Figure 1: Mesophilic aerobic flora levels are expressed as percentagesduring the four seasons investigated.**

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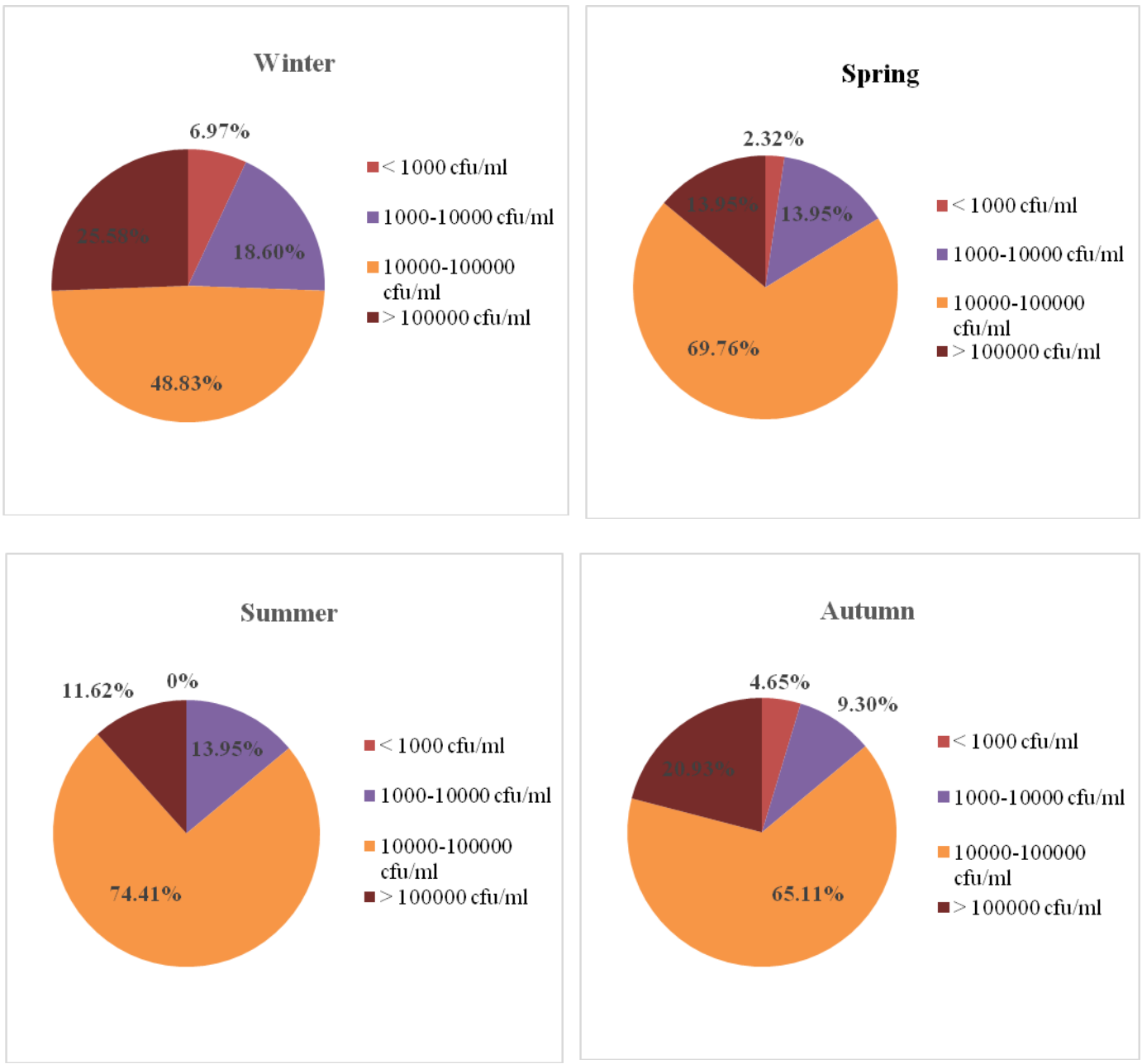


**Figure 2: Total Coliformslevels are expressed as percentages during the four seasons investigated.**

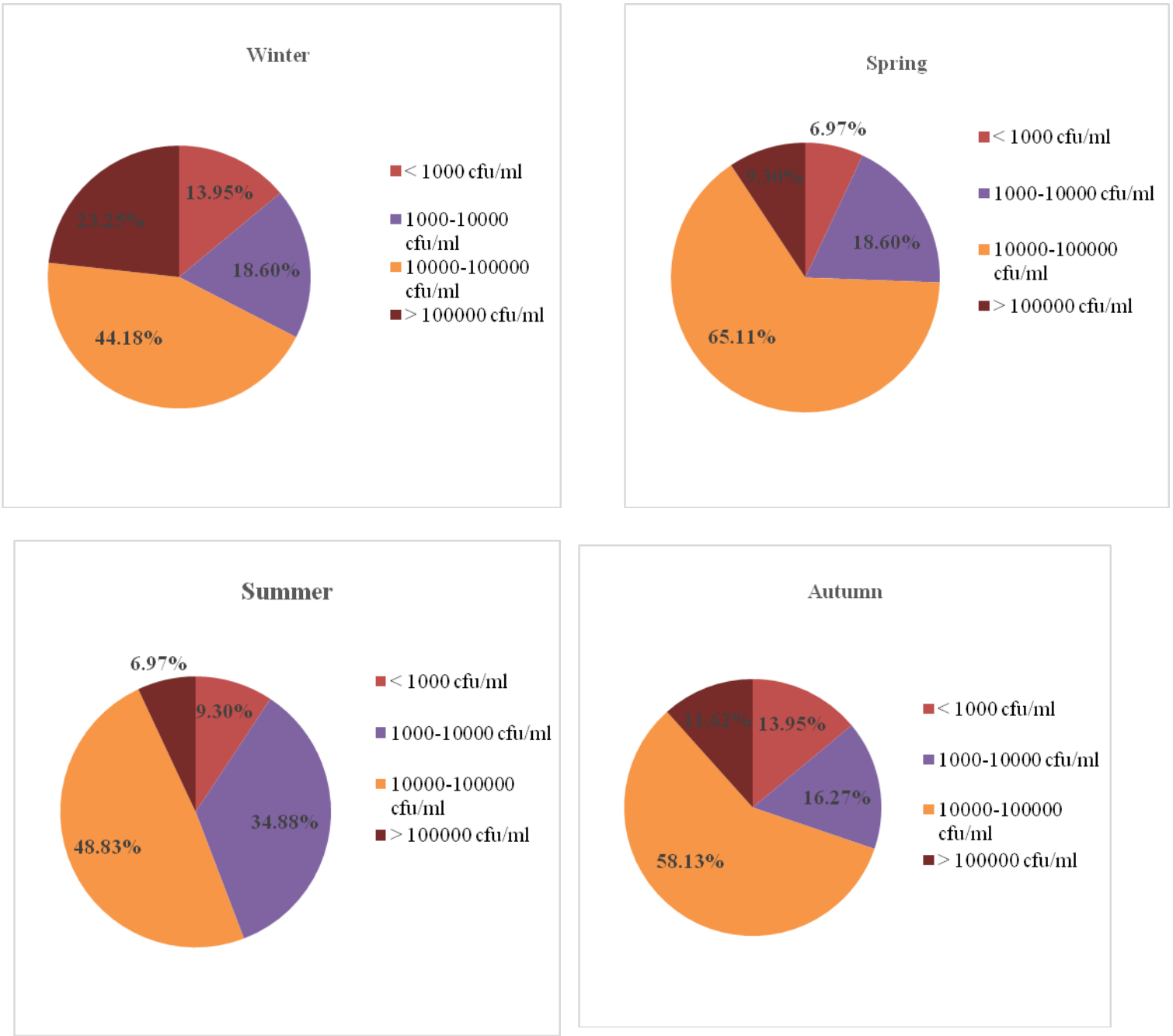


**Figure 3: Total Coliformslevels are expressed as percentages during the four seasons investigated.**

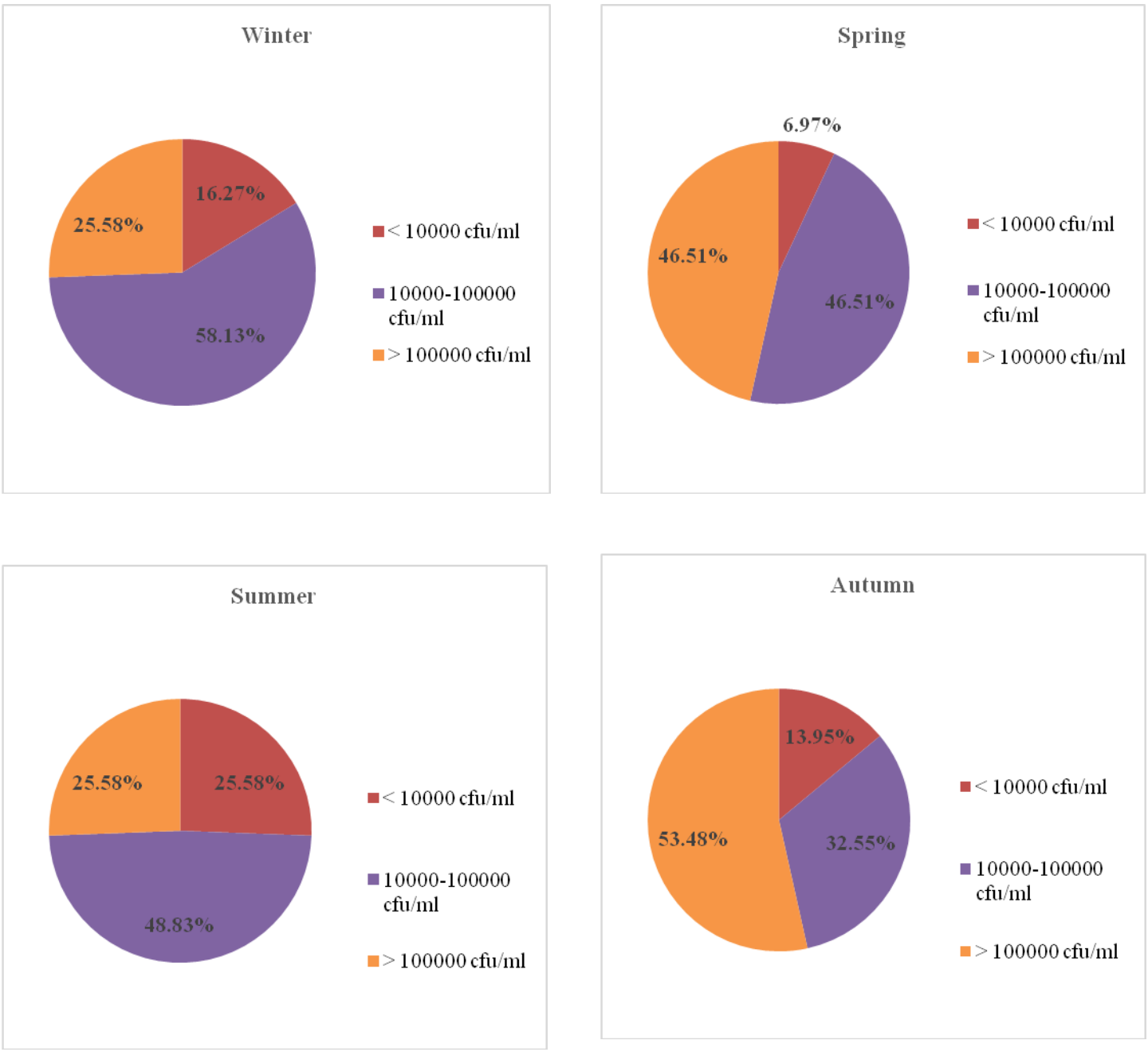


**Figure 4: Percentages of yeast loads in raw cow milk during the four seasons investigated**

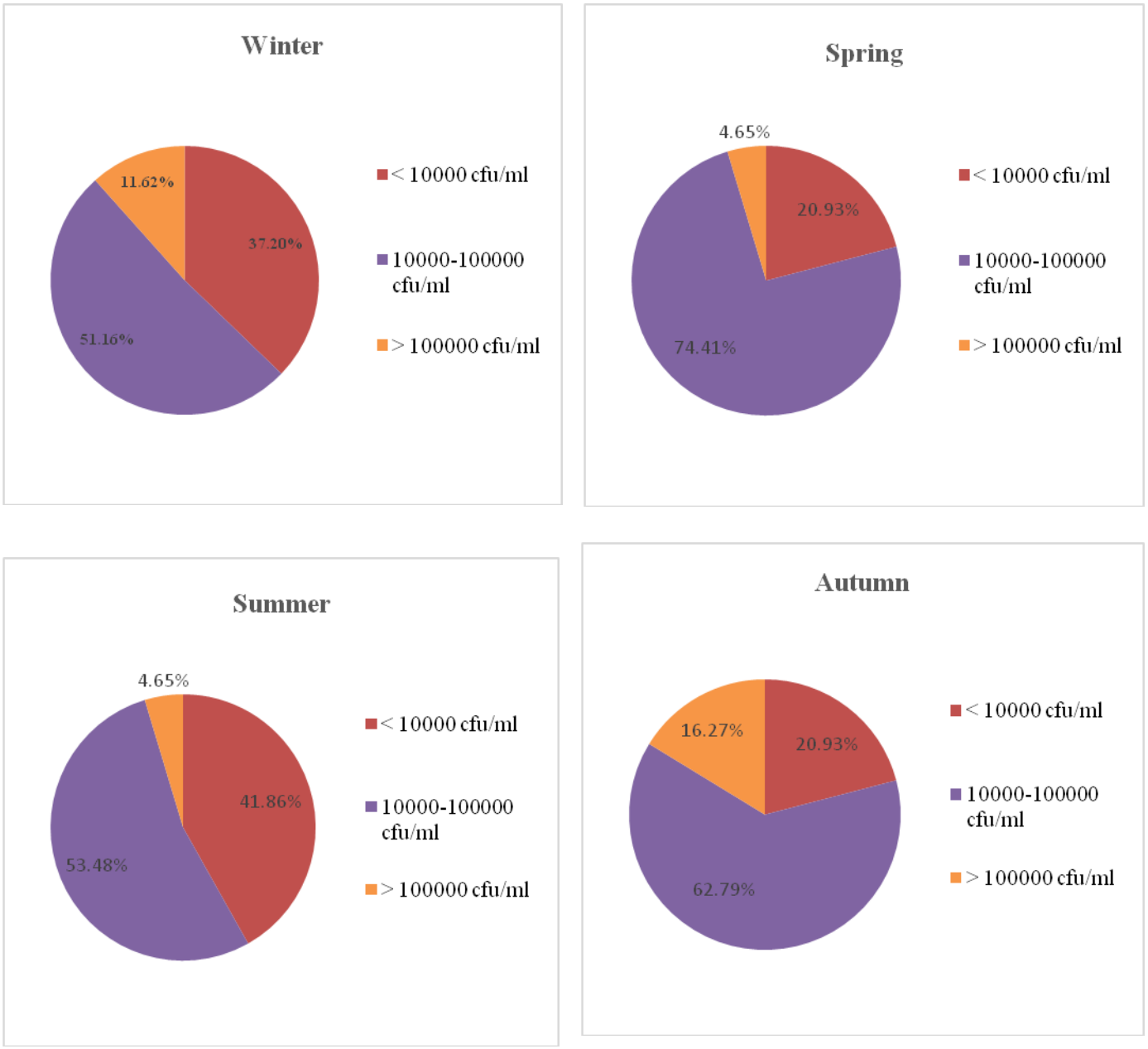


**Figure 5: Percentages of mold loads in raw cow milk during the four seasons investigated.**