The Piedmont Noble Milk as a tool to improve the competitiveness of mountain farms

UNIVERSITÀ DEGLI STUDI DI TORINO

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Introduction

In the mountains of Piedmont (north-western Italy) about 90% of the agricultural area is occupied by permanent meadows and pastures (187,000 ha; ISTAT, 2013) exploited by 7,800 livestock farms. Three thousand farms rear cattle and 50% of them are specialized for milk production. The number of dairy cows is about 19,300 (Sistema Piemonte, 2009), corresponding to 10% of the overall regional bovine stock size. The cows reared in these farms provide 9% of the regional milk production, which is almost completely transformed into dairy products (approximately 2,800 t^{-1} year, corresponding to more than 80% of Piedmont dairy production; Brun *et al*., 2005). Currently, the production of drinking milk has little relevance, in terms of both quantity and economic value. However, in Piedmont as well as in other Italian and European regions, both consumers and producers are more and more interested in drinking milk (especially when produced from extensive farms), to which they assign particular nutritional and healthy properties. Consumers are looking for a product as much as possible similar to raw milk, as shown by the spread of raw milk self-dispensers, whose success is not only referable to the reduced cost per litre. Moreover, milk from extensive dairy systems, being more respectful of animal physiology and welfare, evokes an image of nature, genuineness, and tradition among consumers. From the producer side the production of drinking milk has several advantages. Above all, it offers the possibility to differentiate farm production in order to deal with fluctuations of the demand for local products and with the reduction

in wholesale prices, which sometimes drop below the balance between costs and revenues. Furthermore, it reduces the capital immobilized as cheeses in maturing cells and the costs of labour, especially at the productive peak of the stable, and it may attract the consumers at the point of sale, prompting them to buy other products.

Producers' and consumers' expectations concerning drinking milk can be hardly met in the present situation of the milk industry. Milk is a basic commodity and its market value is largely determined by yields. Only a small part of milk value results from qualitative parameters (i.e., fat and protein contents, total bacterial count and somatic cell count) which do not hold the overall nutritional milk quality. The latter can vary widely depending on animal feeding regime, breed, farming system, milking procedure, processing after milking, etc. (Chilliard *et al*., 2007; Dewhurst *et al*., 2006). Several studies have shown that feeding cattle with fresh grass or hay, if compared to feeding them with unifeed, silages or concentrates, confers high-quality fatty acids, vitamins and antioxidant profiles to bovine milk, making it also a more favourable food for human health (Van Dorland *et al*., 2006).

The milk obtained from cows fed with fresh grass and hay from permanent and highly biodiverse meadows and pastures could be therefore proposed as a viable tool to both overcome the milk market difficulties and to improve the consumers' diet and health.

In this context the "Noble Milk" (Latte Nobile®) brand was born in the Campanian Apennines (southern Italy) in 2011, with the goal of promoting a new drinking milk production model. It assumed that milk produced by animals predominantly fed with fresh grass and hay has intrinsic characteristics that make it distinctive and superior (from both nutritional and health features) if compared to the milk usually available on the market. This innovative model has already been implemented in several regions of central and southern Italy, but it has not been adopted in temperate regions yet. In this paper, we present the first results of a project, funded by the Rural Development Programme 2007-2013 of Piedmont Region, which aims at adapting the "Noble Milk" model to Piedmont conditions, which are different in terms of farming systems, livestock management, characteristics of fodder resources, cow breeds reared and milk production and quality potential from central and southern Italian conditions.

The Noble Milk chains in Piedmont

In Piedmont, the farms potentially interested in the production of Noble Milk may be basically distinguished into two main types. The first type refers to farms able to cope with processing procedures after milking (e.g., heat treatments) and which directly sell their milk. Conversely, the second type refers to farms that sell their milk to dairy processing enterprises, such as dairy industries or cooperatives. For both types of farms, the project evaluated all phases of the supply chain, from feed resources to milk nutritional and microbiological features. In addition, we assessed the consumers' evaluation of Piedmont Noble Milk by triangle tests. All activities involved two small farms located in the province of Torino (belonging to the first chain type) and three farms located in the province of Vercelli (two small farms and the dairy cooperative to which these farms sell their milk, belonging to the second chain type).

The basis of the production chain: highly biodiverse forage resources

The vegetation used for hay production for stable supply and/or as fresh grass for dairy cow grazing was characterized in terms of composition and Pastoral Value (PV, an index that allows summarizing the potential forage value; Daget and Poissonet, 1972). Analysis of data from 156 vegetation surveys carried out with the vegetation point-quadrat method (Kohler *et al*., 2004) on about 200 hectares of grasslands managed by the four farms allowed to recognize 15 different vegetation types. The most represented vegetation types were dominated by *Festuca* gr. *rubra* and *Agrostis tenuis* (28% of the total area), *Brachypodium rupestre* (13%) and *Bromus erectus* (10%). The first vegetation type is nutrient-demanding and typical of moderate slopes. The other two vegetation types are typical of south-facing steep slopes, which are subjected to strong temperature and changes in water availability, with moderate soil nutrient availability. All the vegetation types were characterized by high plant diversity: on the whole, about 340 different plant species and an average of 27 species per survey were detected, with a maximum of 51 species detected in a sub-alpine *Brachypodium rupestre* dominated plant community. For each vegetation survey we evaluated forage productivity and quality, which was determined both by qualitative

chemical analyses and PV. Grasses showed good quality (average PV: 31) and species-richness (especially considering the high number of forbs).

From forage to milk: the cows and their diet

The four dairy farms involved in the project reared on average 20-45 heads per farm, among which 15-35 lactating cows, belonging to different breeds (Aosta Red Pied, Grey Alpine, Brown, Abondance, Montbéliarde),.Yields ranged between 4,000 and 6,000 kg per lactation, corresponding to a daily production of 15-20 kg head^{-1} per day (20-27 kg at lactation peak). During winter these productions were obtained with a ration predominately composed of hay, with limited integrations based on concentrates and/or raw materials (e.g., maize, barley) supplied for less than 20% of diet dry matter. During summer, cattle were grass-fed and only sometimes supplied with limited integrations of concentrates and/or raw materials. During spring transition from hay to fresh grass, the cows were fed hay and fresh herbage from farm permanent meadows either at different proportions, sometimes integrated with concentrates and/or raw materials, depending on the farm. In autumn, during the transition from fresh grass to dry forages, the cows' rations were comparable to the spring ones.

Noble Milk: microbiological, chemical and nutraceutical quality

Basic quality parameters of milk produced in the four farms were evaluated according to Regulation EC 853/2004. Total bacterial and somatic cell counts were considered as indicators of milking and milk production hygiene and udder health, respectively. Automated standard flow cytometric methods were used: BactoScan (Foss Analytical, Hillerød, Denmark) and ISO 13366-2:2006. Moreover, Italian legislation also establishes fat and protein contents in order to determine milk nutritional quality. Milk produced in these farms was monitored analyzing at least two samples per month. Presence of aflatoxin M1 (I'Screen AFLA M1 milk - Tecna Srl, Trieste, Italy) and pathogens such as *Salmonella* spp. (ISO 6579:2002), *Listeria monocytogenes* (ISO 11290-1:1996), Shiga toxin-producing *Escherichia coli* (ISO/TS 13136:2012), *Campylobacter* spp. (ISO 10272-1:2006) and coagulase-positive staphylococci (ISO 6888-2:1999) was evaluated.

Milk samples were in compliance with Regulation EC 853/2004, showing good microbiological quality and low somatic cell counts. In most cases, the nutritional components showed higher concentrations than those defined for High-Quality milk. All raw milk samples were negative for aflatoxin M1 and pathogen microorganisms, while they showed acceptable levels of coagulase-positive staphylococci.

As animal diet has a relevant effect on the composition of milk fat, the fatty acid profile of bulk milk produced in the four farms was analysed in different periods of the year. Milk fatty acid profile was determined by gas chromatography, as detailed in Renna *et al*. (2012). The data were statistically treated by analysis of variance, with the aim to identify differences among periods. The main types of drinking milk available in Piedmont (later on "commercial milk") were purchased in some retail markets in summer 2014 and also analysed for their fatty acid profile, to highlight differences between them and Piedmont Noble Milk.

Piedmont Noble Milk showed the highest concentrations of omega-3 polyunsaturated fatty acids (PUFA n3) and total conjugated linoleic acids (∑CLA) during summer (Figure 1). Compared to the Noble Milk produced in winter, the Noble Milk produced in spring and autumn showed significantly higher concentrations of both PUFA n3 and ∑CLA. Undoubtedly, these results are ascribable to the use of fresh grass in the cattle diet (Couvreur *et al*., 2006). The concentrations of PUFA n3 and CLA in summer commercial milk were comparable to those of the Noble Milk produced in winter and about 3-4 times lower than those of the Noble Milk produced in summer. In the Noble Milk the ratio between PUFA of the omega-6 and omega-3 series (PUFA n6/PUFA n3) as well as the ratio between linoleic and α-linolenic acids (LA/ALA) did not vary significantly among seasons of production. Moreover, they were close to values desirable from a nutritional/health point of view (1:1–4:1), which were typical of the diets of our ancestors (Simopoulos, 2011). On the contrary, commercial milk showed much less favourable PUFA n6/PUFA n3 ratios (range: 3.82–5.50).

Noble Milk: processing

Only with an appropriate processing (pasteurization), packaging and storage, milk maintains all the nutritional qualities resulting from cows' feeding. In order to compare different pasteurization

treatments, the effects of different temperatures and times of pasteurization were studied using microbiological (*Enterobacteriaceae*: < 10 cfu/mL) and enzyme parameters (Alkaline Phosphatase: negative; Peroxidase: positive). High-Temperature-Short-Time Treatment (HTST) allowed a good microbiological quality during the shelf life. Milk was bottled into different type of bottles (glass and Polyethylene terephthalate - PET) at different temperatures. Mesophilic and psycrophilic bacteria were monitored (ISO 4833:2003; ISO 6730:2005). These bacteria, if present at high concentrations, might alter the organoleptic properties of the product such as taste, smell and appearance, limiting the shelf life of the pasteurized milk. Acceptable values of these parameters were measured during the entire shelf-life, although the bottles were stored at moderate thermal abuse (+ 8°C).

Consumers' evaluation

In the proposal for a new product, such as Piedmont Noble Milk, the ability of consumers to perceive the differences with respect to similar products normally available on the market is a key element for the success of the product itself. As part of the project, to assess this ability two days were dedicated to sensorial evaluations. Two different untrained panels of about 120 people each underwent 450 triangle tests. Samples of pasteurized milk of the four farms involved in the project and samples of High-Quality milk of the most common commercial milk brands sold in Piedmont region were compared. The 88% of the testers correctly identified the Noble Milk, which was considered as having a higher taste intensity, persistence, freshness and flavour.

Conclusions

In Piedmont, cattle reared in extensive farms exploit species-rich meadows and pastures characterized by good forage quality. Direct exploitation (i.e., grazing) is probably the best way to exploit such forages conveniently and to obtain milk with higher nutritional values if compared to milk produced from intensive farming systems. The skill of breeders results in both outstanding milk quality and high hygienic standards. These features can be maintained for several days after packaging, favouring prolonged product conservation, just applying simple processing such as

pasteurization at 72° for 1 min. This technique can also be adopted at farm level and in small dairies, even outside industrial pasteurisation plants.

The results obtained from the Piedmont Noble Milk project show the possibility to use this peculiar milk production as a tool for diversifying the production of mountain farms, increasing their competitiveness at market level. The models that have be defined for mountain areas might also be transferred to other extensively managed farms.

Acknowledgements

Research funded by Regione Piemonte – Rural Development Program 2007-2013 Measure 124.1-Health Check. We are grateful to the farmers Dino Agù, Daniele Bermond, Maria Antonietta Ferraris, and Filiberto Vaira, and to Raffaella Cattarelli and Marco Cottini (Caseificio Alta Valsesia) for their essential contribution to the project.

References

F. Brun, A. Mosso, E. Xausa, La montagna in cifre: rapporto statistico sulle terre alte del Piemonte. Regione Piemonte, 71 pp. **(2005)**

Y. Chilliard, F. Glasser, A. Ferlay, L. Bernard, J. Rouel, M. Doreau, Diet, rumen biohydrogenation and nutritional quality of cow and goat milk fat. *European Journal of Lipid Science and Technology*, 109, 828-855 **(2007)**

S. Couvreur, C. Hurtaud, C. Lopez, L. Delaby, J. L. Peyraud, The linear relationship between the proportion of fresh grass in the cow diet, milk fatty acid composition, and butter properties. *Journal of Dairy Science*, 89, 1956-1969 **(2006)**

P. Daget and J. Poissonet, Un procédé d'estimation de la valeur pastorale des pâturages. *Fourrages*, 49, 31-39 **(1972)**

R. J. Dewhurst, K. J. Shingfield, M. R. F. Lee, N. D. Scollan, Increasing the concentrations of beneficial polyunsaturated fatty acids in milk produced by dairy cows in high-forage systems. *Animal Feed Science and Technology*, 131, 168-206 **(2006)**

F. Kohler, F. Gillet, J. M. Gobat, A. Buttler, Seasonal vegetation changes in mountain pastures due to simulated effects of cattle grazing. *Journal of Vegetation Science*, 15, 143–150 **(2004)**

ISO 6888-2:1999 Microbiology of food and animal feeding stuffs -- Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) -- Part 2: Technique using rabbit plasma fibrinogen agar medium **(1999)**

ISO 6579:2002/Cor 1:2004 Microbiology of food and animal feeding stuffs -- Horizontal method for the detection of *Salmonella* spp. **(2004)**

ISO 11290-1:1996/Amd 1:2004 Microbiology of food and animal feeding stuffs -- Horizontal method for the detection and enumeration of Listeria monocytogenes -- Part 1: Detection method **(2004)**

ISO 6730:2005 (IDF 101:2005) Milk -- Enumeration of colony-forming units of psychrotrophic microorganisms -- Colony-count technique at 6,5 degrees C **(2005)**

ISO 10272-1:2006 Microbiology of food and animal feeding stuffs -- Horizontal method for detection and enumeration of Campylobacter spp. -- Part 1: Detection method **(2006)**

ISO 13366-2:2006 (IDF 148-2: 2006) Milk -- Enumeration of somatic cells -- Part 2: Guidance on the operation of fluoro-opto-electronic counters **(2006)**

ISO/TS 13136:2012. Microbiology of food and animal feed -- Real-time polymerase chain reaction (PCR)-based method for the detection of food-borne pathogens -- Horizontal method for the detection of Shiga toxin-producing Escherichia coli (STEC) and the determination of O157, O111, O26, O103 and O145 serogroups **(2012)**

ISO 4833-1:2013 Microbiology of the food chain -- Horizontal method for the enumeration of microorganisms -- Part 1: Colony count at 30 degrees C by the pour plate technique **(2013)**

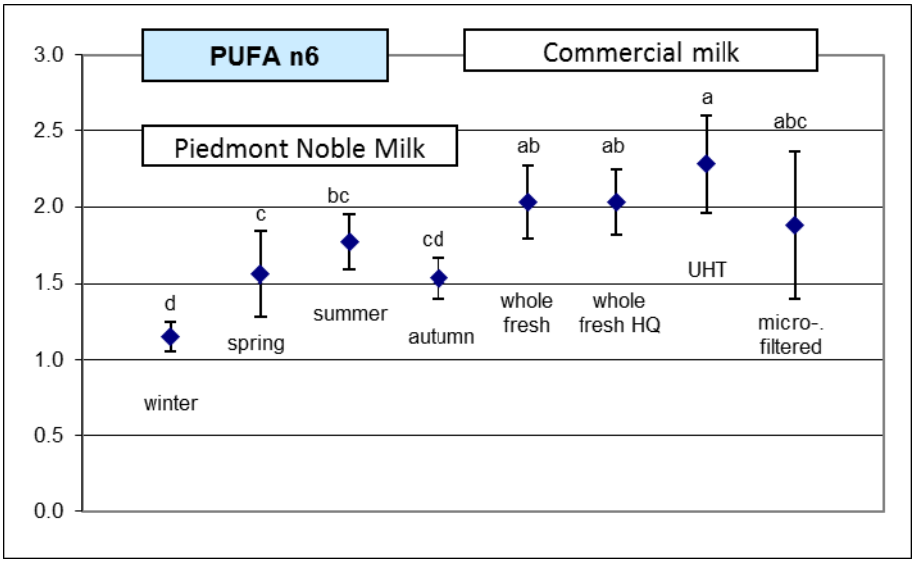
ISTAT. Sixth Italian General Census of Agriculture. 197 pp. **(2013)**

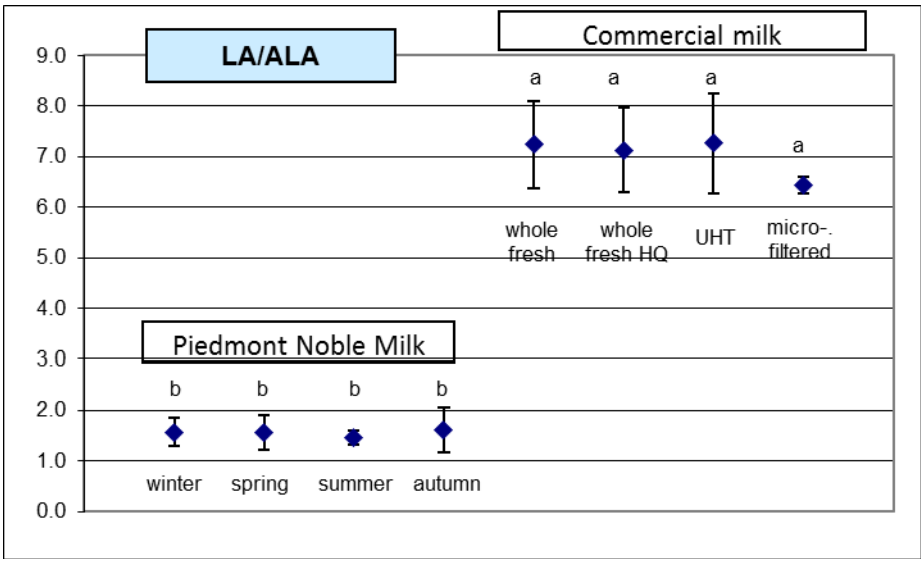
M. Renna, P. Cornale, C. Lussiana, V. Malfatto, R. Fortina, A. Mimosi, L. M. Battaglini, Use of *Pisum sativum* (L.) as alternative protein resource in diets for dairy sheep: effects on milk yield, gross composition and fatty acid profile. *Small Ruminant Research*, 102, 142-150 **(2012)**

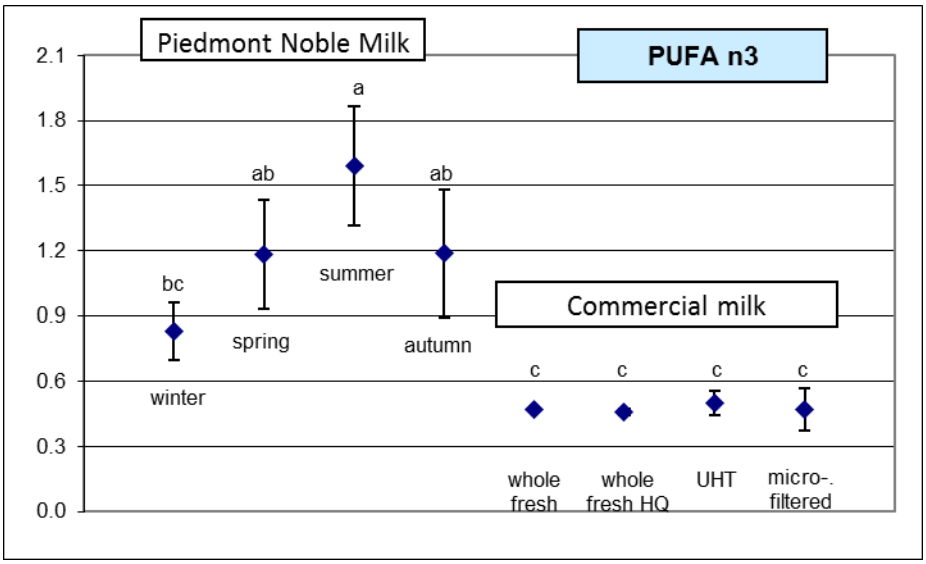
A. P. Simopoulos (2011). Importance of the omega-6/omega-3 balance in health and disease: evolutionary aspects of diet. In: Simopoulos A.P. (Ed.), “Healthy Agriculture, Healthy Nutrition, Healthy People”. Karger, Washington, D.C., pp. 10-21 **(2011)**

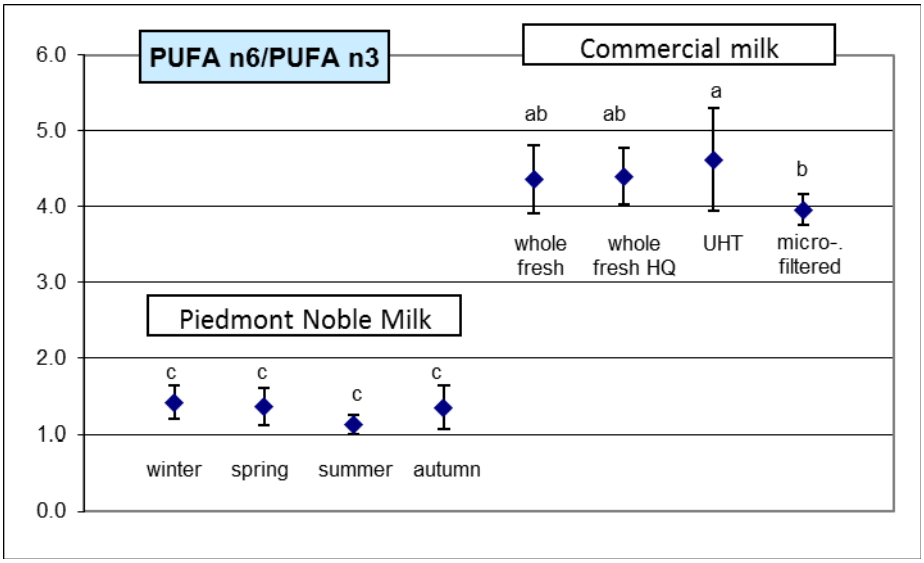
H. A. Van Dorland, H.-R. Wettstein, M. Kreuzer. Species-rich swards of the Alps: constraints and opportunities for dairy production. In: Elgersma A., Dijkstra J., Tamminga S. (Eds.), “Fresh Herbage for Dairy Cattle”, Springer, Dordrecht, The Nederlands, pp. 27-43 **(2006)**

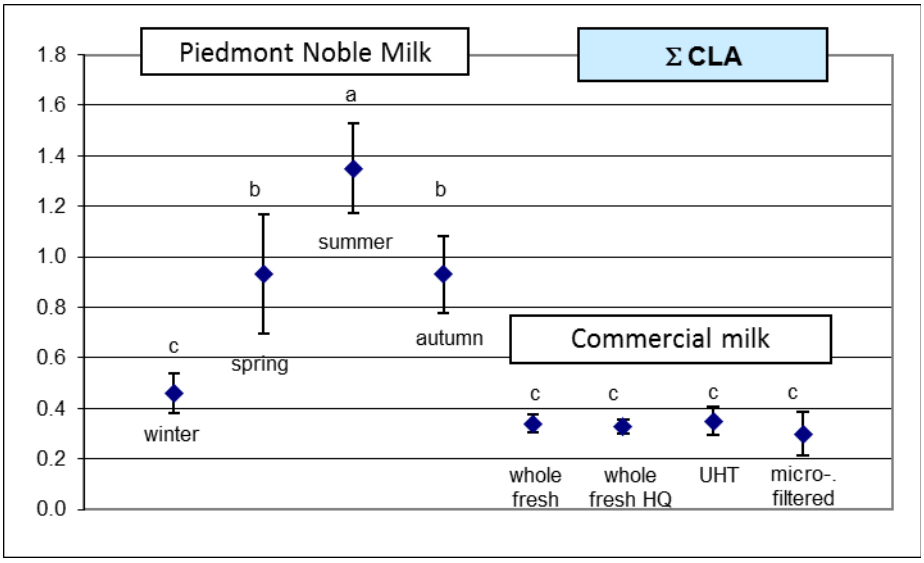
Figure 1 – Contents of milk fatty acids (PUFA: polyunsaturated fatty acids; LA: linolenic acid; ALA: α-linolenic acid; CLA: conjugated linoleic acid). Values expressed in g 100 g^{-1} fat. Identical letters identify treatments that did not significantly differ from each other.






Piedmont Noble Milk
PUFA n3
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
a
ab
ab
bc
summer
spring
autumn
winter
Commercial milk
c
c
c
c
whole fresh
whole fresh HQ
UHT
micro-. filtered


PUFA n6/PUFA n3
Commercial milk
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ab
ab
a
b
whole fresh
whole fresh HQ
UHT
micro-. filtered
Piedmont Noble Milk
c
c
c
c
winter
spring
summer
autumn


Piedmont Noble Milk
Σ CLA
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
a
b
b
c
summer
spring
autumn
winter
Commercial milk
c
c
c
c
whole fresh
whole fresh HQ
UHT
micro-. filtered