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CHEMICAL AND NUTRITIONAL CHARACTERIZATION OF BRAND AND PRIVATE LABEL DAIRY PRODUCTS: UHT CREAM, A CASE STUDY

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Recently, Private Label (PL) products are widespread in all supermarket shelves. At the beginning consumers believed that these food items had poor quality, but now PL products have considerably improved and are in constant competition with national Brand (B) products. Apart from the price, it's very hard for consumers to understand the real differences between B and PL products. For this purpose, using cream as a case study, the proximate composition, fat soluble vitamins, cholesterol, minerals, and the colour parameters of different Brand and Private Label UHT creams with ≥ 20% milk fat were evaluated. Moreover, two tracing parameters, such as the Degree of Retinol Isomerization (DRI) and the Degree of Antioxidant Protection (DAP) were assessed. Principal Components Analysis showed that protein, fat and carbohydrate contents, together with DRI and the colour parameters a* and b*, were the variables most influencing the separation between PL and B creams on the first two Principal Components. Nevertheless, it was very hard to discriminate PL from B creams: this was probably due to the heterogeneity of the samples (differences in raw materials or different manufacturing processes), as well as to seasonal changes in milk composition or cows' breed.

Keywords: UHT cream, Brand and private label, Chemical composition, Multivariate analysis

INTRODUCTION

Private Label (PL) items are defined as "products owned and branded by the organizations whose primary objective is distribution rather than production" (Shutte, 1969). PLs made their first appearance on the 1970s; since then most of the big retail stores and small retail chains launched their private brands. In the UK private label's market share grew from 16.4% to 30% (from 1975 to 1997) while PL products in Europe rose 28% from 1993 to 1998 (Steiner, 2004), and since 2013 PL foods have spread on a global basis. In 2016, the Private Label outperformed the national Brands, and as a result PLs advanced + 4.2% compared to only + 0.2% for the Brands (Nielsen, 2017a). Moreover, according to the latest Nielsen sales and market share statistics, the Private Labels reached maximum values in market share in 9 European countries (Nielsen, 2017b).

Over the last two decades many Private Label foods have been developed. At the beginning, there was common agreement that Private Label quality left much to be desired: PL foods were only the generic and cheaper versions of Brand products (B), but recently they have improved in quality, and are still in constant competition with national Brand products. Investing in their Private Labels has become a focal strategy for the retailers, who are seeking more and more ways to differentiate themselves from one another and to develop customer loyalty.

Many studies were carried out to understand what factors might encourage their increased consumption in order to develop effective strategies to attract more and more consumers (Schroeter and Cai, 2012). An Indian study (Selvakumar, 2013) showed that the customers were ready to buy Private Label foods such as rice or wheat, and most

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of the customers would prefer to try new Private Labels in the future, even if food quality was more important than price for all consumers.

Private Label foods represent, on the whole, a good marketing strategy in order to increase the loyalty of consumers and ensuring an economic margin to producers. According to the literature (Schroeter and Cai, 2012), the quality of Private Label foods has been improved but very few studies are able to describe the nutritional quality of Private Label products (Trevena *et al.*, 2015; and Ahuja *et al.*, 2017).

Among PL foods, dairy products are well represented, and creams are common in market shelves too. Cream, mainly used as an ingredient in industrial or home-made patisserie, is a dairy product composed of the higher-butterfat layer: in many countries cream is sold in several grades depending on the total butterfat content. According to the Codex Alimentarius (FAO and WHO Codex Alimentarius, 2011) cream is the fluid milk product comparatively rich in fat, in the form of an emulsion of fat-in-skimmed milk, obtained by physical separation from milk with milk fat > 10% (w/w). Food and Drug Administration (2013) classifies cream into: 1) heavy cream with > 36% milk fat; 2) light cream with 18-30% milk fat; 3) light whipping cream with 30-36% milk fat. In the UK the cream classification is much more complex (UK Regulation, 1995): 1) double cream with > 48% milk fat; 2) whipping cream and whipped cream with > 35% milk fat; 3) sterilized cream with > 23% milk fat; 4) cream or single cream with > 18% milk fat; 5) half cream and sterilized half cream with > 12% milk fat. In Italy creams are classified as: 1) coffee cream with ≥ 10% milk fat; 2) cream with ≥ 20% milk fat; 3) whipping cream with ≥ 30% milk fat (Italian Law, 1974).

Many works were carried out in order to evaluate the processing effects on the physical and chemical properties of cream (Bolling *et al.*, 2005; Komatsu *et al.*, 2012; and Boitz and Mayer, 2016), but very few studies are available in the literature about chemical and nutritional quality of cream and, furthermore, most of them are early (Muir and Kjaerbye, 1996; and Sieber *et al.*, 1996).

This work tries to identify differences in chemical and nutritional properties between PL and B dairy products (information being generally lacking in literature) to provide a useful tool of choice to the consumers and, in particular, creams were chosen as a case study. This research was focused on Brand (B) and Private Label (PL) UHT Italian creams, with ≥ 20% milk fat. The work also aims to give an update of the chemical and nutritional data about UHT creams.

MATERIALS AND METHODS

Samples

Different brands of commercially available UHT creams with fat ≥ 20% were collected from Italian stores and supermarkets; all the samples were stored at room temperature prior to analysis, as indicated on the label. The analysed samples were divided as follows:

- 7 samples (three different batches for each sample) of Private Label UHT cream (PL1 - PL7)
- 7 samples (three different batches for each sample) of national Brand UHT cream (B1 - B7)

Chemicals

All reagents used were of HPLC (high performance liquid chromatography) grade or at least of the highest purity available. Standards were obtained from Sigma Aldrich (St Louis, MO, USA) and Merck KGaA, (Darmstadt, Germany). Ultrapure water was prepared by an ion exchange system to >18 mΩ cm resistivity (Millipore, MA, USA).

Equipment and Conditions

Water, protein, fat and ash contents were determined according to the Italian Official methods for Cheese analysis (Italian Official methods for Cheese analysis, 1986), while total carbohydrates were determined by difference.

Total energy was calculated according to the following equations (Regulation EU, 2011):

Energy (kJ) = (17 x g protein) + (17 x g carbohydrate) + (37 x g lipid) ...(1)

Energy (kcal) = (4 x g protein) + (4 x g carbohydrate) + (9 x g lipid) ...(2)

In order to determine the fat soluble vitamins and cholesterol the samples were saponified and extracted according to the method of Panfili *et al.* (1994) prior to the HPLC analysis. Chromatographic separation was performed on an Alliance 2695 (Waters, Milford, MA, USA) equipped with fluorescence (Model 2475) and UV/VIS (Model 2487) detectors. The extracted residue was dissolved in the mobile phase (n-hexane with 1% of 2-propanol), filtered and analysed by normal phase HPLC with gradient elution (Panfili *et al.*, 1994) using a Kromasil column (250 x 4.6 mm,

5µm, Phenomenex Inc., Torrance, CA, USA). The quantification of the fat soluble compounds was carried out by fluorimetric (*alpha* tocopherol: excitation 280 nm, emission 325 nm; 13-*cis* retinol and *trans* retinol: excitation 325 nm, emission 475 nm) and UV-Vis (cholesterol 208 nm; *beta* carotene 450 nm) detectors connected in series.

The Degree of Retinol Isomerization (DRI) parameter was calculated from the retinol isomers contents: it is defined as the 13*cis* retinol/*trans* retinol percentage ratio (Panfili *et al.*, 1998).

The Degree of Antioxidant Protection (DAP) was calculated as the molar ratio between the antioxidant compounds (*alpha* tocopherol and *beta* carotene) and the oxidation target (cholesterol), according to Pizzoferrato *et al.* (2007); it is expressed in the exponential form ($x10^{-3}$).

Minerals were determined after samples ashing: 5g of creams were weighed into platinum crucibles and ashed in the furnace at 525 °C for 16 h. Calcium, magnesium and phosphorus were determined according to the AOAC methods (2002), also applied for sodium and potassium determinations. Ca, Mg, Na, and K were determined by an Atomic Absorption Spectrometer A. Analyst 300 (Perkin Elmer, Norwalk, CT), while phosphorus was measured at 400 nm by an UV-1800 spectrophotometer (Shimadzu Corporation,Tokyo, Japan).

The measurements of colour were performed using a handled tristimulus colorimeter (Konica Minolta CR-400, Minolta Limited, Milton Keynes, UK), with a D65 illuminant, an angle of observation of 0° and an 8 mm diameter field of view. Prior to the analysis the colorimeter was calibrated for light source with a white calibration tile. L*, a* and b* coordinates were measured in the CIELab space.

All measurements were carried out in triplicate.

Statistical Analysis

XL-STAT Base 18.06 (Addinsoft 1995-2017) software was used to perform statistical analysis. Differences in the mean values between PL and B creams were evaluated by the t-test analysis and were considered significant at $p < 0.05$.

Principal Component Analysis (PCA) and Cluster Analysis (CA) were performed on the data matrix including protein, fat, ash, carbohydrate, minerals, colour coordinates, DRI, and DAP values. PCA was performed after data autoscaling, and CA was carried out using the Word's method algorithm.

RESULTS AND DISCUSSION

In Table 1 the mean values of the proximate composition, energy value, fat soluble compounds, minerals, quality parameters and colour coordinates of Private Label and Brand UHT creams are reported.

According to the obtained data no differences ($p \geq 0.05$) were detected (also on dry matter data) for water, fat, ash, and carbohydrate contents between PL and B creams. Additionally, fat content was in compliance with the law (milk fat ≥ 20%) in all samples: the average fat content was 23.1 g/100 g and 23.7 g/100 g for PL and B creams, respectively.

Cream is mainly used as an ingredient in industrial or homemade patisserie. Even if it is not realistic to think about eating 100 g of cream, it's true that 100 g of UHT creams provide 232 kcal/100 g (958 kJ/100 g) and 235 kcal/100 g (969 kJ/100 g) for PL and B UHT creams, respectively.

Among the macronutrients, statistical analysis showed a difference ($p < 0.05$) in the protein contents (also on dry matter data): 3.5 g/100 g on average for PL creams and 3.1 g/100 g on average for B creams. It was hard to explain these differences in the protein contents, due to the numerous issues affecting milk production and composition. Brun-Lafleur *et al.* (2010) showed that protein and fat yield in milk increased with an improved energy and protein supply in the breeding system, as well as Hansen *et al.* (2006) showed that not only the composition but also the production of milk were affected by the parity and genotype of cows. Furthermore, since there are no restrictive regulations on cream, the addition of milk powder could be possible in cream: FAO and WHO Codex Alimentarius (2011), for example, provides the use of creams made by reconstitution or recombination, in which milk powders and cream powders may be added.

Cream is generally known as a dairy product with a high fat content. For this reason, from a nutritional point of view, it is important to evaluate the fat soluble compounds of cream. In Table 1 cholesterol and fat soluble vitamin (*alpha* tocopherol, *beta* carotene and retinol isomers) contents of the studied UHT creams are reported. Concerning the cholesterol contents, no significant difference was detected between PL (mean value 69.3 mg/100 g) and B (mean value 67.0 mg/100 g) samples (also on dry matter data).

Regarding the fat soluble vitamins, it is commonly accepted that these compounds are mainly in the milk fat fraction such as cream or butter (Gaucheron, 2011). As it

Table 1: Proximate Composition, Energy Value, Fat Soluble Compounds, Minerals, Quality Parameters and Colour Coordinates of Private Label and Brand UHT Creams, Data are Means of Triplicate Analyses with Standard Deviation

	Private Label UHT Creams			Brand UHT Creams		
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**
Proximate Composition						
Water (g/100 g)	70.2 ± 1.0	68.7	71.7	70.3 ± 1.7	66.9	71.9
Protein (g/100 g)	3.5 ± 0.3[a]	3.2	4.0	3.1 ± 0.3[b]	2.6	3.5
Fat (g/100 g)	23.1 ± 1.2	21.0	24.8	23.7 ± 2.4	22.3	28.5
Ash (g/100 g)	0.5 ± 0.0	0.5	0.6	0.6 ± 0.0	0.5	0.6
Carbohydrate (g/100 g)	2.6 ± 0.5	2.1	3.3	2.3 ± 0.7	1.4	3.1
Energy						
kcal/100 g	232 ± 10	216	247	235 ± 19	218	273
kJ/100 g	958 ± 40	893	1019	969 ± 78	901	1125
Fat Soluble Compounds						
Cholesterol (mg/100 g)	69.3 ± 3.1	65.4	73.6	67.0 ± 5.4	63.1	78.6
α-tocopherol (µg/100 g)	509.4 ± 67.1	417.9	618.4	477.3 ± 50.1	372.1	525.2
β-carotene (µg/100 g)	38.4 ± 10.4[a]	29.7	60.0	64.4 ± 21.8[b]	26.0	92.3
13-*cis* retinol (µg/100 g)	21.0 ± 3.5	15.3	26.0	24.1 ± 9.5	15.1	43.9
trans -retinol (µg/100 g)	316.8 ± 31.9[a]	265.4	359.2	262.9 ± 64.1[b]	210.7	387.7
Minerals						
Ca (mg/100 g)	76.9 ± 9.3	58.8	86.6	85.2 ± 6.6	75.4	91.8
P (mg/100 g)	72.1 ± 4.2	65.5	76.2	74.9 ± 4.1	69.9	79.7
Na (mg/100 g)	31.1 ± 3.1	28.1	35.3	30.0 ± 1.9	27.8	33.3
K (mg/100 g)	111.6 ± 4.4	104.0	118.4	115.8 ± 4.6	110.4	123.1
Mg (mg/100 g)	7.6 ± 1.4	5.0	9.3	8.4 ± 0.6	7.4	9.0
Ca/P (molar ratio)	0.8 ± 0.1	0.6	0.9	0.9 ± 0.1	0.8	0.9
Quality Parameters						
DRI (%)	6.6 ± 1.1[a]	5.7	8.8	9.2 ± 2.5[b]	4.9	12.1
DAP	7.0 ± 0.9	5.8	8.1	7.1 ± 1.2	4.5	8.2
Colour Coordinates						
L*	83.1 ± 0.112	82.8	83.2	83.2 ± 0.4	82.6	83.6
a*	-2.51 ± 0.53[a]	-2.88	-1.35	-1.38 ± 0.28[b]	-1.64	-0.87
b*	7.03 ± 0.46[a]	6.67	7.21	7.86 ± 0.91[b]	6.22	8.82

Note: Values in the same raw with different superscript letters are significantly different ($p<0.05$).

was expected, their amounts in the analysed creams were higher than in cow milk, whose values are generally in the range 80-160 µg/100 g for *alpha* tocopherol, 5-30 µg/100 g for *beta* carotene and 30-60 µg/100g for retinol (Hulshof *et al.*, 2006; Plozza *et al.*, 2012; and Manzi *et al.*, 2013).

The mean values of *alpha* tocopherol contents were 509.4 µg/100 g in PL creams and 477.3 µg/100 g in B creams, resulting in no difference between the two classes of samples (also on dry matter data).

Concerning the *beta* carotene values, the results in Table 1 show that this compound was significantly lower ($p<0.05$) in PL (38.4 µg/100 g) than in B creams (64.4 µg/100). As it was known, the feeding of green stuff to cows leads to an increase in both carotene and fat contents (Moore, 1932; and Nozière *et al.*, 2006a). The differences in the *beta* carotene values between PL and B creams (also observed on dry matter data) could be probably due to a difference in the nature of the cows' forage: actually, it is recognized that carotenoids moves from herbage to cows altering milk and dairy products colours (Nozière *et al.*, 2006b).

Trans retinol content was significantly higher ($p<0.05$) in PL than in B creams (316.8 *vs* 262.9 µg/100 g), while no difference was observed for the 13-*cis* retinol isomer (also on dry matter data). The double bonds in the chain of retinoids can undergo *cis*-*trans* isomerization (positions 9, 11 and 13) during technological processes, due to factors affecting vitamin A stability such as heat, light, and low pH (Loveday and Singh, 2008): unfortunately, *cis* isomers account for the least vitamin A activity (Weiser and Somorjai, 1992).

The Degree of Retinol Isomerization represents a parameter related to the "severity" of different processing techniques: it is expressed as the percentage ratio between 13-*cis* and *trans* retinol. DRI value generally enhances with the severity of heat treatments in milk (Panfili *et al.*, 1998; and Manzi *et al.*, 2013). In all UHT cream samples DRI ranged from 4.9% to 12.1%: these values were in agreement with former data of Panfili *et al.* (1999), where the isomerization degree of UHT creams was on average 12%. The t-test analysis of the results showed that DRI values significantly differed ($p<0.05$) between PL and B creams (same results obtained on dry matter data): 6.6% and 9.2%, respectively. However, the heterogeneity of the samples, probably due to differences in the raw materials and/or to different industries and process technologies, made it very difficult to justify these differences in the commercial samples.

The Degree of Antioxidant Protection is a parameter related to food quality, since it is a measure of milk and cheese resistance to oxidative reactions. No significant difference was observed in the DAP values between PL and B creams: 7.0 and 7.1, respectively. Pizzoferrato *et al.* (2007) found DAP values greater than 7 in milk and cheese from grazing goats, compared to values lower than 7 in samples from zero-grazing goats, showing that grazing results in milk enrichment with compounds able to protect cholesterol against oxidative reactions. In the same way, higher DAP values were found in milk from grazing cows compared to milk samples from zero-grazing cows (Manzi *et al.*, 2012; and Puppel *et al.*, 2017).

Concerning the mineral fraction of the UHT creams, Table 1 reports calcium, phosphorous, sodium, potassium and magnesium contents of the studied samples. As it is well known, all dairy products are rich in minerals, but these are differently distributed into the aqueous and micellar phases of milk, depending on their nature: potassium and sodium are essentially in the aqueous phase, while calcium and phosphorous are partially bound to the casein micelles and partially in the aqueous phase of milk (Gaucheron, 2011). Calcium and phosphorous in creams were respectively 76% and 80% of these minerals in milk, and sodium was about 80% compared to the same content in milk (Manzi *et al.*, 2013).

The obtained results (Table 1) revealed that PL and B creams showed no significant differences (also on dry matter data) in none of the minerals investigated. More in details, calcium content was in the range 58.8-91.8 mg/100 g, sodium content ranged between 27.8 and 35.3 mg/100 g, phosphorous was in the range 65.5-79.7 mg/100g, and potassium ranged between 104.0 and 123.1 mg/100 g. Furthermore, magnesium, an essential cofactor for several enzymes, ranged between 5.0 and 9.3 mg/100 g.

Generally, an adequate calcium intake for bone health is well established and the optimal dietary Ca/P molar ratio is suggested to be approximately 1.0 (Bonjour, 2011). According to the obtained data, both PL and B creams showed a good Ca/P molar ratio (0.8 and 0.9, respectively).

The changes in the samples' colour were evaluated by the determination of the colour parameters (L^*, a*, and b^*). Table 1 reports the L* (lightness) values for PL and B creams, whose values were on average 83.1 and 83.2, respectively. The colour coordinate a* (red/green value) showed significant differences ($p<0.05$) between PL and B creams,

being on average -2.51 and -1.38, respectively. Also the b* parameter (yellow/blue value) was statistically higher ($p<0.05$) in the B creams, with mean values equally to 7.86 and 7.03, respectively. The b* coordinate (yellow index) of the all samples matched with the overall *beta* carotene content ($R^2 = 0,919$) and, in detail, in Figure 1 the correlation between the b* value and the *beta* carotene of PL and B creams is reported. The results showed a significant positive correlation between these two parameters ($R^2 = 0,836$ and $R^2 = 0,920$ for PL and B creams, respectively). This correlation in cream was better than that observed by Agabriel *et al.* (2007) in tanker milk ($R^2 = 0,389$).

From a nutritional point of view, it is unlikely to eat cream alone. However, cream is often used as mean ingredient in industrial or homemade patisserie, ice-cream and other foodstuffs. So, it could be a useful tool to know its nutritional value, in order to address, especially the industry, towards a proper nutritional assessment when cream is used in mixture with other ingredients.

In many countries there is no indication about cream portion (SINU, 2014; and BDA, 2017), while some database, such as USDA (USDA, 2016) reports cream composition data for 100 g, cup (60 g) or table spoon (3 g). For this reason, a reasonable compromise could be to refer the nutritional assessment to 100 g of cream.

From a nutritional point of view, cream cannot be certainly considered a good source of vitamin E: according to the results, in fact, 100 g of PL creams provide 3.9% and 4.6% of the vitamin E daily intake (Table 2), referred to the Adequate Intake (AI) established by EFSA (2017), for males and females ≥ 18 years, respectively. At the same time, 100 g of B creams provide 3.7% of the vitamin E daily intake for males and 4.3% for females.

Taking into account the different contribute of *beta* carotene, 13-*cis* and *trans* retinols to the vitamin A activity, 100 g of PL creams provide 45.2% for males and 52.1% for females (Table 2) of the vitamin A daily intake, referred to the Population Reference Intake (PRI) established by EFSA (2017) for adults ≥ 18 years. The vitamin A activity of the B creams was instead lower: 38.9% for males and 44.9% for females.

Taking into account the population nutrient intake goal established by WHO/FAO (2002) to reduce the cholesterol intake to < 300 mg/die (for the prevention of the cardiovascular diseases), 100 g of B and PL creams respectively supply 22.3% and 23.1% of the cholesterol daily intake.

The recommended dietary allowance for calcium, instead, is about 950 mg/die for adults ≥ 25 years (EFSA, 2017): therefore, 100 g of PL and B creams respectively provide 8.1% and 9.0% of the calcium daily intake (Table 2).

Figure 1: *beta* Carotene (µg/100 g) *vs* b*Colour Parameter in Private Label (PL) and Brand (B) UHT Creams

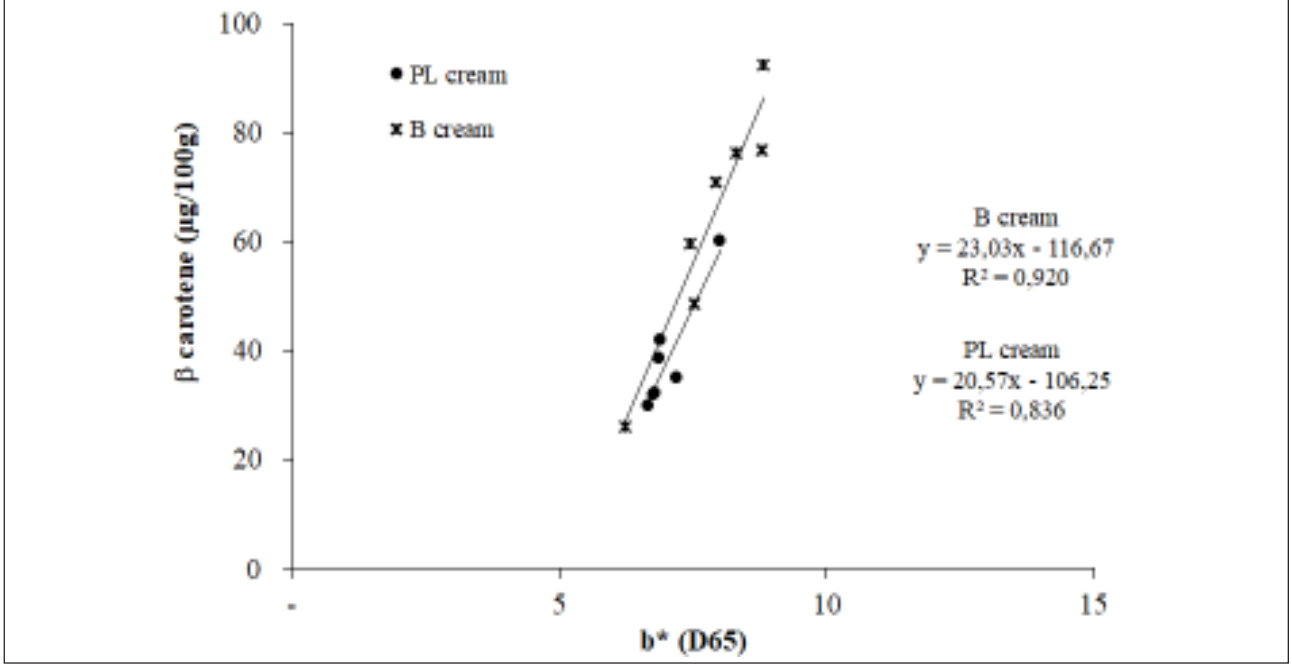


Table 2: Percentage (%) Contribution of Daily Requirements of Some Compounds Supplied by 100 g of Private Label and Brand UHT Creams

	Private Label UHT Creams			Brand UHT Creams		
	Adults	**Males**	**Females**	**Adults**	**Males**	**Females**
Fat Soluble Compounds						
Vitamin E		3.9	4.6		3.7	4.3
Vitamin A		45.2	52.1		38.9	44.9
Cholesterol	23.1			22.3		
Minerals						
Calcium	8.1			9.0		
Phosphorus	13.1			13.6		
Sodium	1.6			1.5		
Potassium	3.2			3.3		
Magnesium		2.2	2.5		2.4	2.8

Note: Vitamin A intake is referred to the EFSA Population Reference Intake (PRI) for males and females ≥ 18 years (EFSA, 2017); Vitamin E intake is referred to the EFSA Adequate Intake (AI) for males and females ≥ 18 years (EFSA, 2017); Cholesterol intake is referred to the population nutrient intake goal established by WHO/FAO (adults < 300 mg/die) (WHO/FAO, 2002); Calcium intake is referred to the EFSA Population Reference Intake (PRI) for adults ≥ 25 years (EFSA, 2017); Phosphorus, Potassium intakes are referred to the EFSA Adequate Intake (AI) for adults ≥ 18 years (EFSA, 2017); Magnesium intake is referred to the EFSA Adequate Intake (AI) for males and females ≥ 18 years (EFSA, 2017); Sodium intake is referred to the WHO recommendation (< 2 g/die) (WHO, 2012).

The % daily contribution of the other minerals (phosphorus, potassium and magnesium) reported in Table 2 are referred to the AI established by EFSA (2017) for adults ≥ 18 years: 100 g of PL and B creams respectively supplied 13.1% and 13.6% of the phosphorus intake and 3.2% and 3.3% of the potassium intake. Concerning the magnesium intake, 100 g of PL creams provided 2.2% for males and 2.5% for females, compared to 2.4% and 2.8%, respectively, supplied by 100 g of B creams.

Concerning sodium intake, WHO (2012) recommends a reduction to < 2 g/day sodium (5 g/day salt) in adults to reduce blood pressure and risk of cardiovascular disease, stroke and coronary heart disease. According to this recommendation, 100 g of PL and B creams respectively provide 1.6% and 1.5% of the sodium daily intake (Table 2).

In order to visualize the data structure of the UHT creams, Principal Component Analysis (PCA) was applied as an unsupervised multivariate analysis method. Figure 2 shows the score plot of the samples projected on the first two Principal Components (PCs). It can be seen how the second Principal Component (PC2), which accounts for 19.2% of the total variance, shows a satisfactory separation between Private Label and Brand UHT creams. Since PL and B samples were well separated in Figure 2, the loadings were inspected in order to identify the most relevant original variables contributing to the observed separation. Table 3 shows high negative loadings for protein and carbohydrates on PC2, meaning that PL UHT creams are characterised by higher values of these macronutrients compared to the Brand UHT creams, which instead show higher values of a*, DRI, b*, and fat. The loading values on PC2 were in agreement with the results of the t-test analysis: protein, DRI, a* and b* values showed, in fact, significant differences between PL and B samples. Furthermore, even if the t-test showed that fat and carbohydrates mean values were not significantly different between PL and B creams, the distribution of these two populations was different (see min-max values in Table 1).

The score plot on the first two PCs also reveals a major heterogeneity of the Brand UHT creams compared to the Private Label products. Since there is no restrictive regulation on cream, there is no standardization in the

Table 3: Loadings of the Original Set of Variables Associated with the First Two Principal Components (PCs)

Variables	PC1	PC2
Protein	0.219	-0.366
Fat	-0.315	0.313
Ash	0.361	0.039
Carbohydrate	0.296	-0.236
DRI	-0.004	0.403
L*	-0.036	0.048
a*	-0.015	0.532
b*	0.22	0.36
Ca	0.328	0.214
P	0.362	0.111
Na	0.303	-0.153
K	0.315	0.116
Mg	0.291	0.198
DAP	0.267	0.031

production process, resulting in heterogeneity of the samples.

In Figure 3 the dendrogram obtained by the hierarchical clustering method (CA) is shown. Samples are clustered in two major groups: the former made up of PL1, B1, B3, B5 and B6 creams, the latter formed by PL6, B7, PL2, PL4, B2, PL3, B4, PL5 and PL7 samples. The classification made by Clustering Analysis seems to reflect the separation of the creams on the first Principal Component (PC1) in Figure 2. Actually, PC1 explains the most of the total variance in the data set (42.2% in this case), and it could be probably related to the production process of the creams or to the same raw materials used (probably coming from the same origin place).

A further investigation of the sample labels based on the classification shown by the dendrogram in Figure 3, in fact, revealed that the B2 Brand also produces the PL2, PL3, PL4 and PL5 samples, which are all clustered in the same group. Furthermore, B7 was produced in a manufacturing plant located in the same province of B2. At the same time, PL6 and PL7 samples were produced in the same manufacturing plant. The fact that a single Brand might produce more Private Label food items could also explain the homogeneity of the PL samples observed in the PCA score plot (Figure 2).

Figure 2: Score Plot of the Samples Projected on the First Two Principal Components (PCs), PL1-PL7: Private Label UHT Creams, B1-B7: Brand UHT Creams

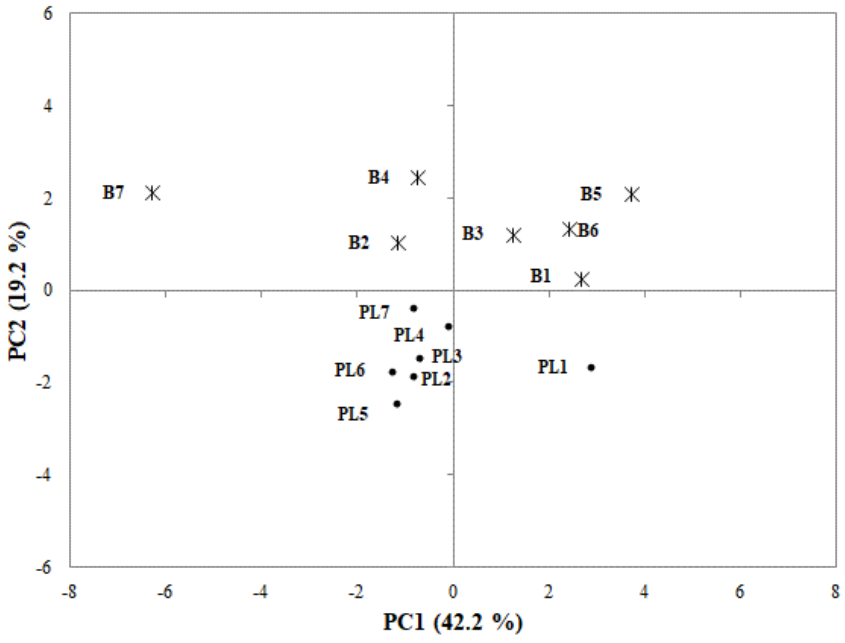
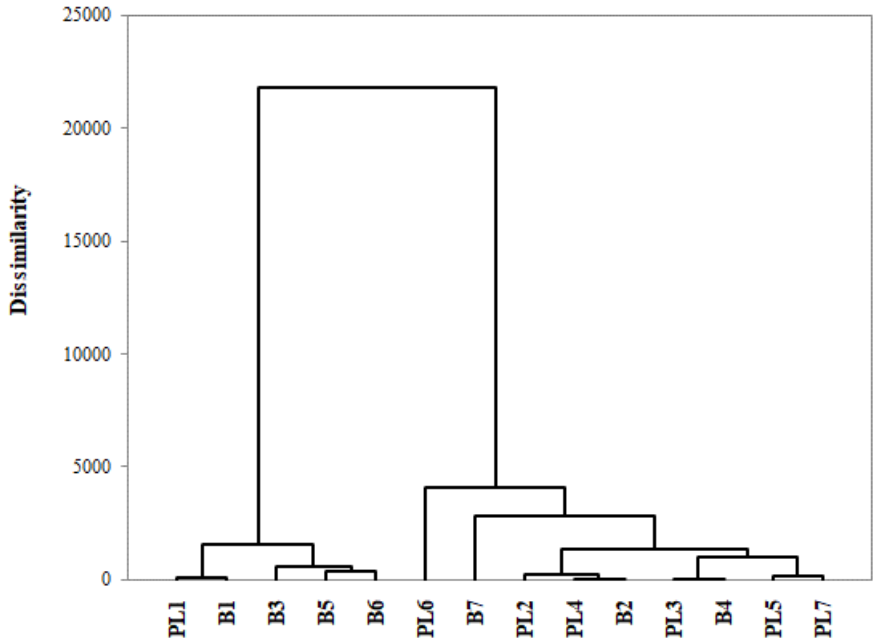


Figure 3: Dendrogram Obtained by the Cluster Analysis, PL1-PL7: Private Label UHT Creams, B1-B7: Brand UHT Creams



CONCLUSION

Since Private Labels have become popular, the competition with national Brands has become increasingly strong. Furthermore, PLs could generally represent a good marketing strategy for the retails, who are seeking more and more ways to differentiate themselves from one another in order to increase consumers' loyalty. However, the real differences between Private Label and Brand foods are not always clear, also due to the fact that one Brand could produce more than one Private Label. In this context the consumers do not have the suitable tools to be able to choose between Private Label and Brand foods.

This work tried to identify differences in chemical and nutritional properties between PL and B foods (information being generally lacking in the literature) so as to provide a useful tool of choice to the consumers; cream was chosen as a case study. The work also aimed to give an update of the chemical and nutritional data about UHT creams.

Principal Components Analysis applied to proximate composition, cholesterol, some minerals, the colour parameters and the two tracing parameters DRI and DAP allowed to identify the variables major contributing to the separation between Private Label and Branded creams. Also, Cluster Analysis showed a classification of the samples, probably according to the manufacturing plant and/or to the technological process.

Nevertheless, the heterogeneity of the samples, due to differences both in raw materials and manufacturing processes, made it very hard to clearly discriminate between PL and B creams.

Further studies, also increasing the sample numerosity, are therefore needed to describe the chemical and nutritional quality of the Private Label products in order to better identify differences with Brand products.

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