Variability of cardoon flowers technological properties for cheesemaking of *Cynara cardunculus* L. populations from Alentejo (Portugal)

INTERNATIONAL SCIENTIFIC CONFERENCE ON RAW MILK

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GRUPO OPERACIONAL SERPAFLORA

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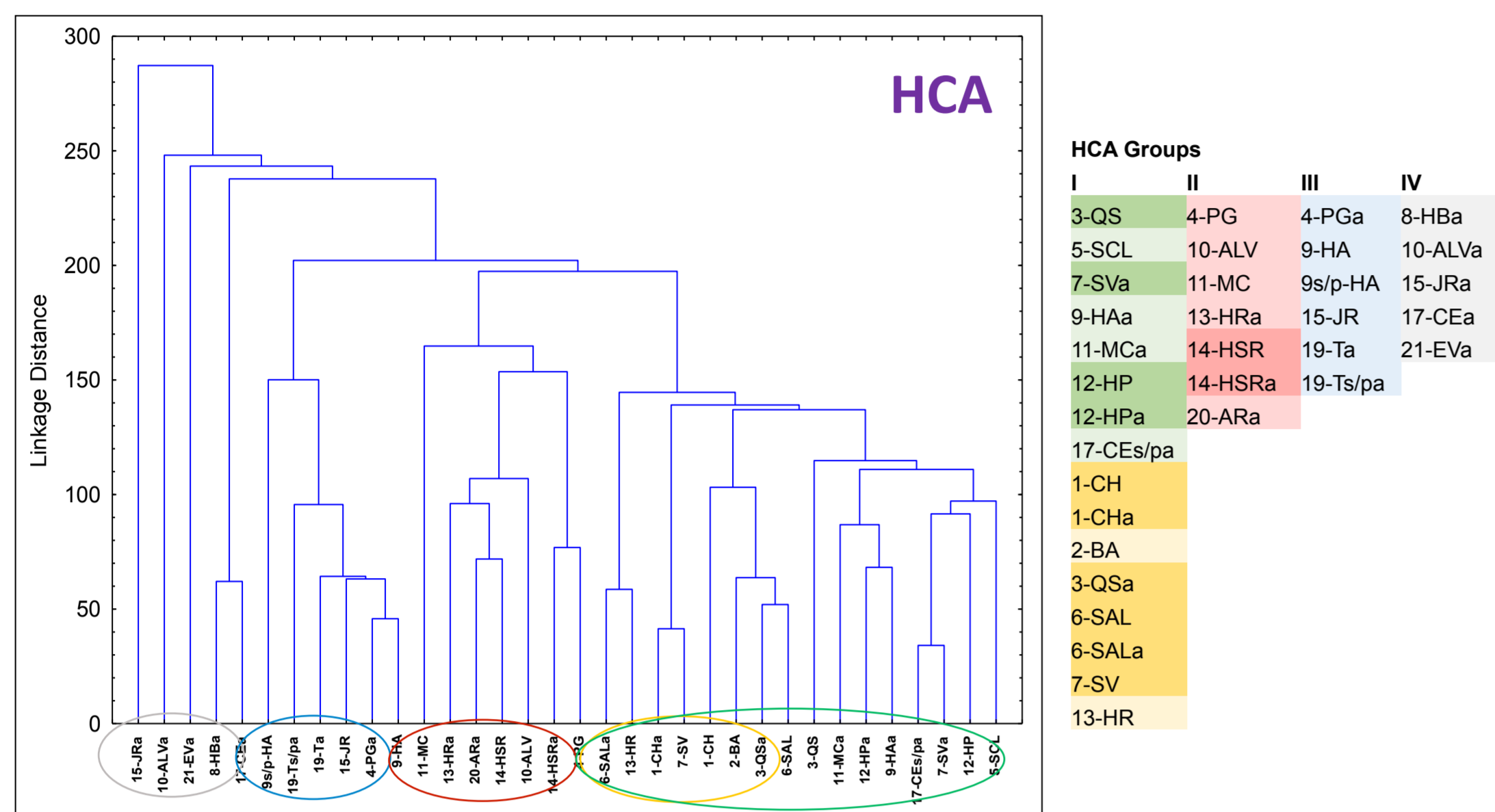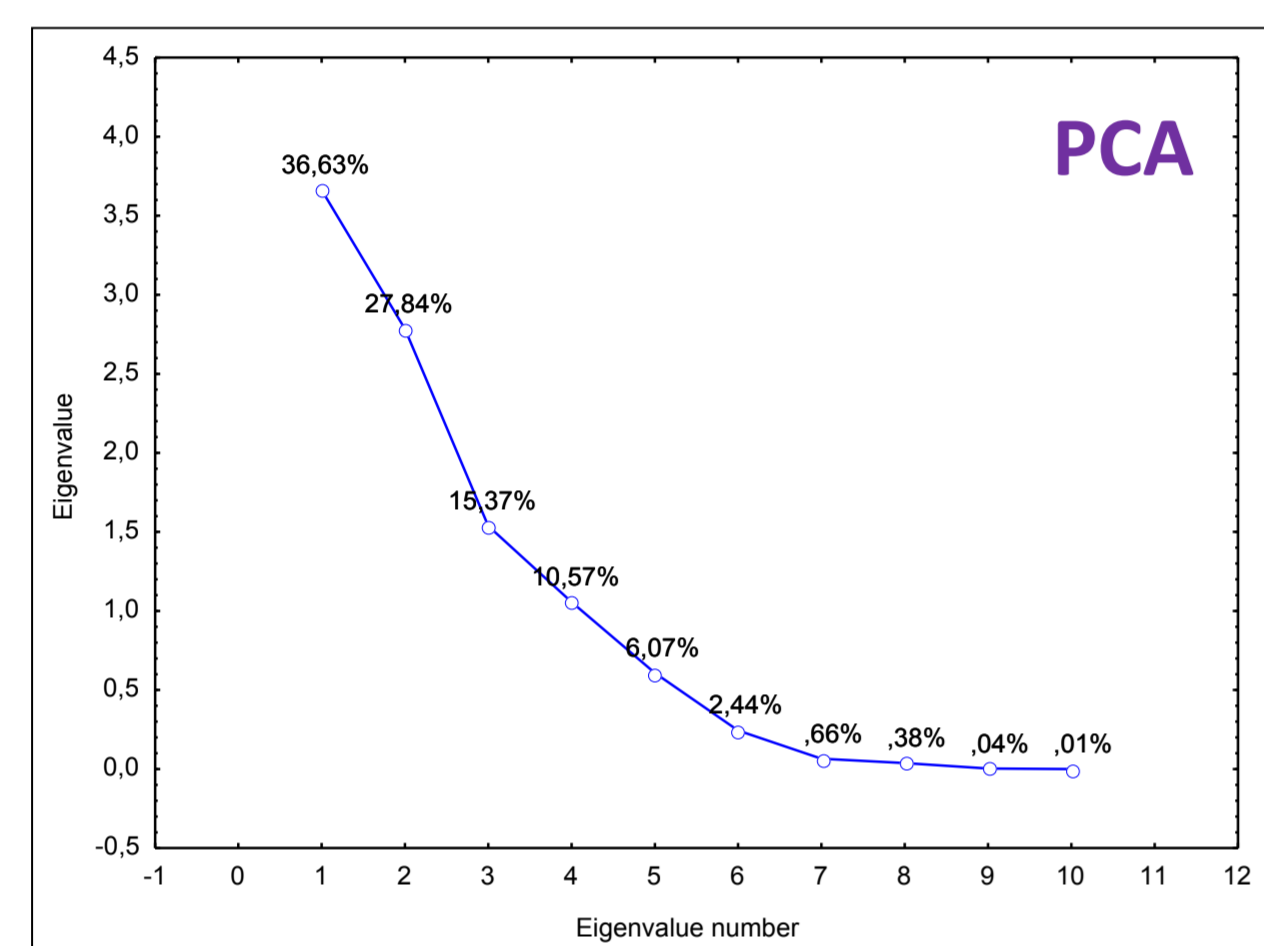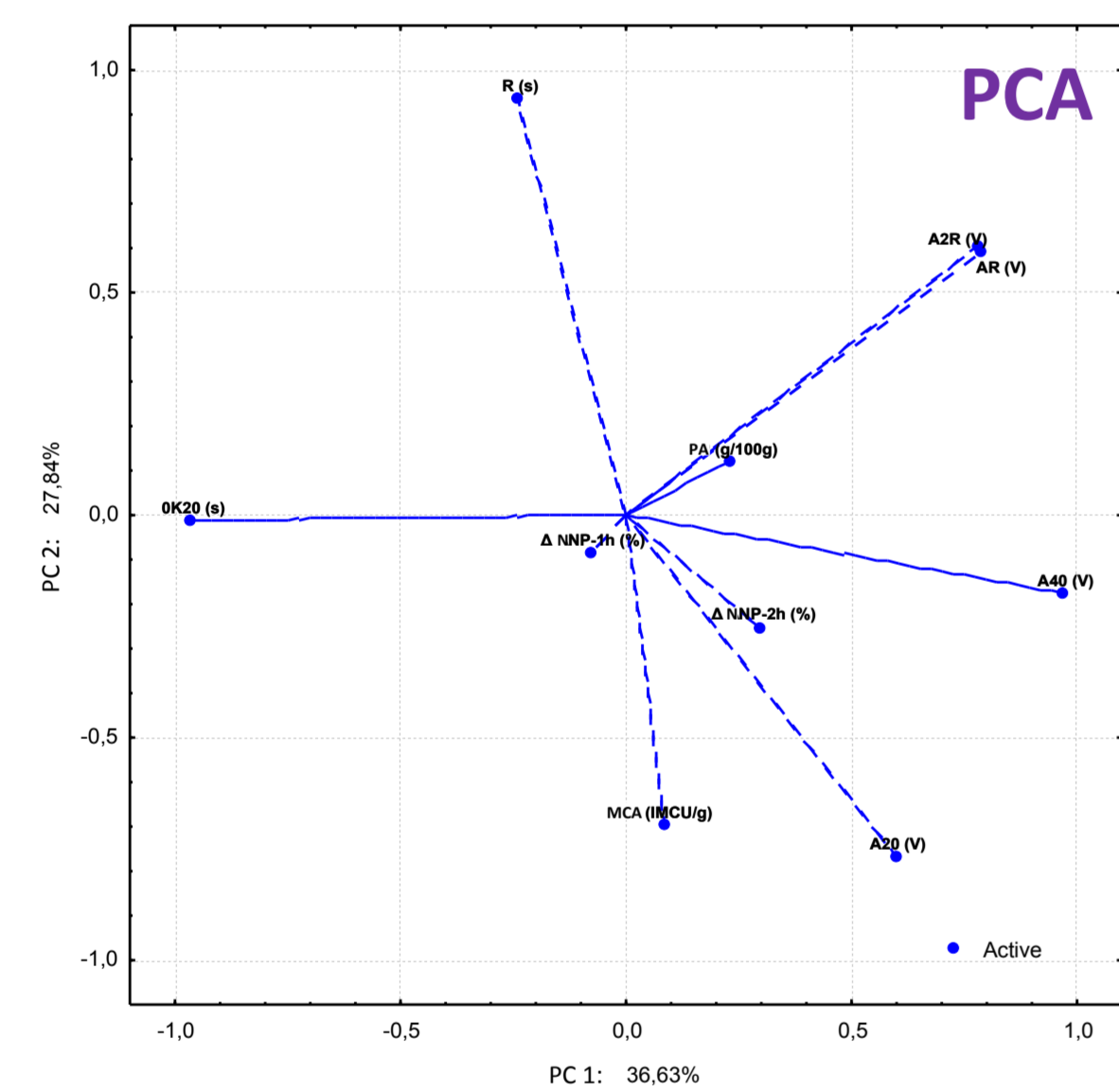
Results and Discussion

Fig.1: Dendrogram obtained after cluster analysis (Single linkeage, Euclidean Distance) using all the variables evaluated and composition of the formed groups (distance level of 200).

HCA Groups			
I	II	III	IV
3-QS	4-PG	4-PGa	8-HBa
5-SCL	10-ALV	9-HA	10-ALVa
7-SVa	11-MC	9s/p-HA	15-JRa
9-HAa	13-HRa	15-JR	17-CEa
11-MCa	14-HSR	19-Ta	21-EVa
12-HP	14-HSRa	19-Ts/pa	
12-HPa	20-ARa		
17-CEs/pa			
1-CH			
1-CHa			
2-BA			
3-QSa			
6-SAL			
6-SALa			
7-SV			
13-HR			

Fig.2: Principal Component Analysis (PCA) – Percentage of total variance explained by each Eigenvalue.

	Eigenvalue	Variance explained (%)	Total variance explained (%)
1	3,663	36,627	36,627
2	2,784	27,840	64,466
3	1,537	15,372	79,839
4	1,057	10,569	90,408
5	0,607	6,074	96,482
6	0,244	2,441	98,923
7	0,066	0,656	99,580
8	0,038	0,378	99,958
9	0,004	0,037	99,994
10	0,001	0,006	100,000

	PC1	PC2	PC3
MCA (IMCU/g)	0,082	-0,696	-0,092
R (s)	-0,239	0,936	0,131
AR (V)	0,785	0,595	0,032
A2R (V)	0,778	0,604	0,022
A20 (V)	0,597	-0,767	-0,092
A40 (V)	0,969	-0,175	-0,042
0K20 (s)	-0,967	-0,012	-0,099
Δ NNP-1h (%)	-0,080	-0,086	0,919
Δ NNP-2h (%)	0,298	-0,253	0,629
Y (g/100g)	0,233	0,121	-0,501

Fig.3: Projection of the technological properties evaluated in the *C. cardunculus* L populations in the plan defined by the first two principal components (PC 1 and PC 2 where 64% of the total variance is explained) and their correlations within considered technological properties (10 selected in 13 evaluated).
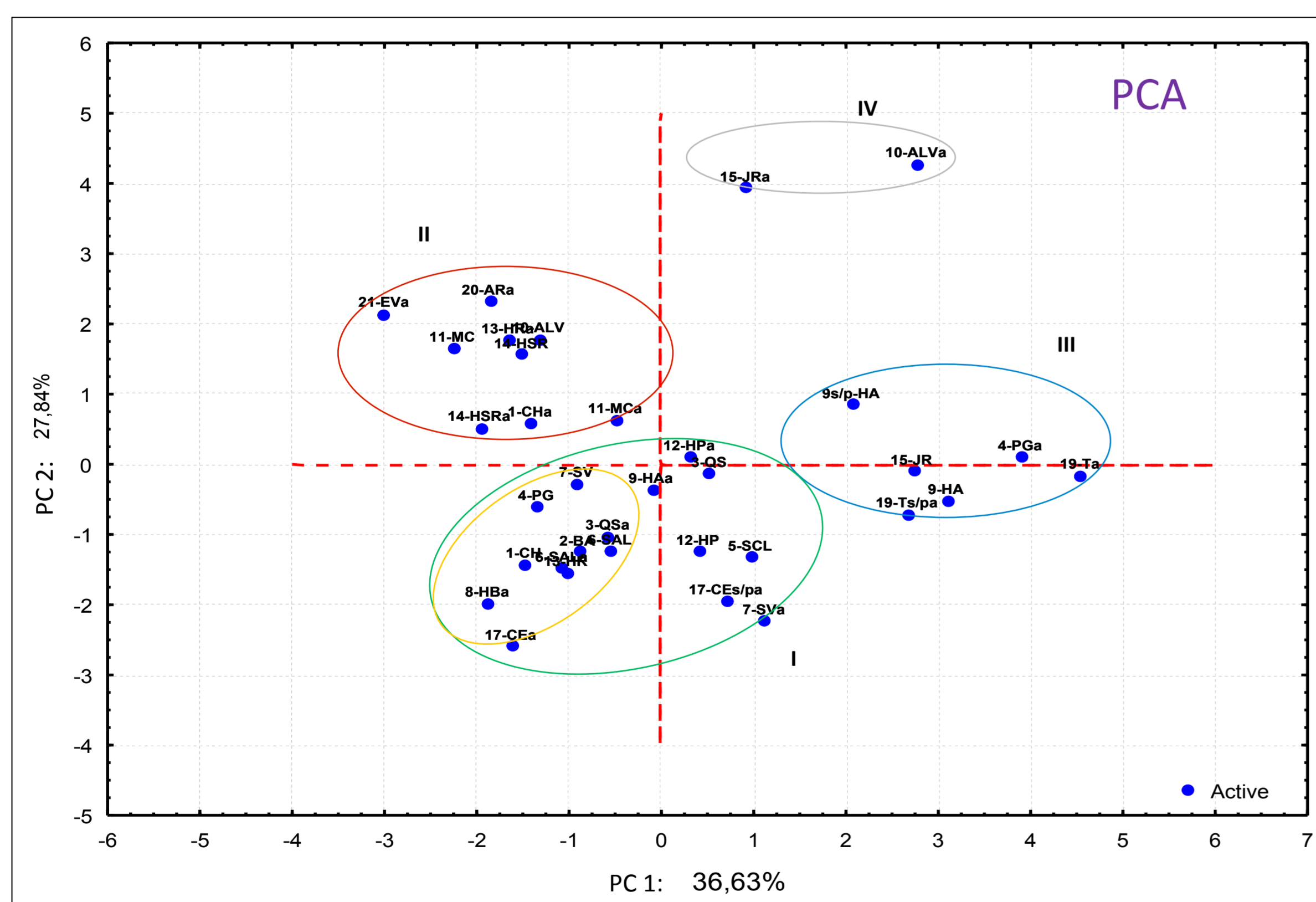

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1-CH	21-EVa		
2-BA	1-CHa		
3-QSa			
6-SAL			
6-SALa			
7-SV			
13-HR			
4-PG			
8-HBa			
17-CEa			

Fig.4: Projection of the 34 cardoon flower samples collected in the 2 years, representing 22 populations of *C. cardunculus* L. grouped, based on the average results for 10 properties in the plan defined by the principal components PC 1 and PC 2 (annexed table).

✓ HCA using all the evaluated variables, discriminated the samples into 3 main groups (Fig. 1);
A fourth group comprised samples with more differentiated properties, which joined the 3 main groups at very high distances.

✓ PCA discriminated populations into **3 main groups (groups I-III)** using PC1 and PC2, explaining 65% of the total variance found among *C. cardunculus* L. flower samples (Fig. 4), **which can be characterized as**:
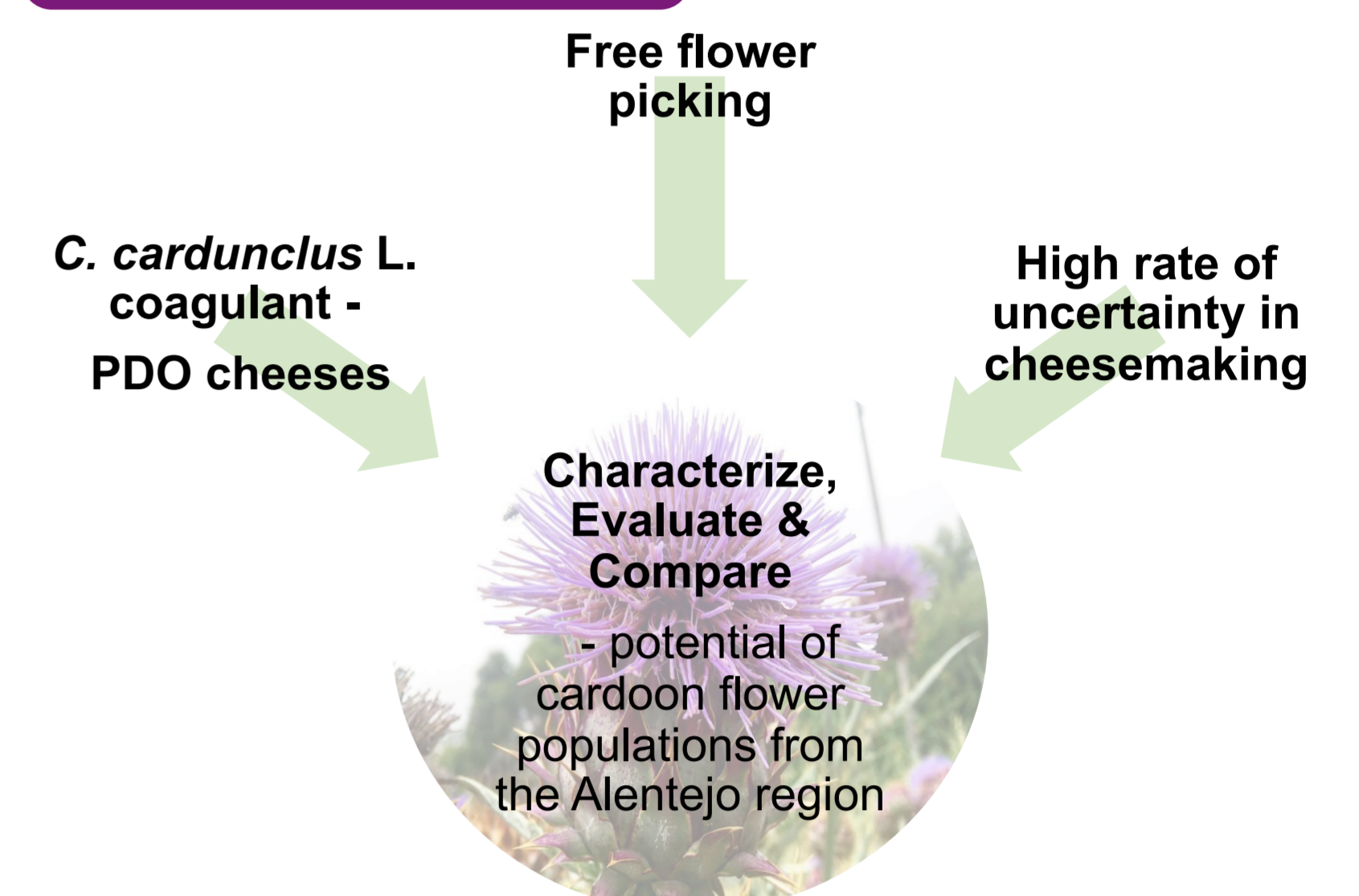
Group I: high MCA, good milk clotting properties, average micellar aggregation rate, medium to high non-specific PA, average cheesemaking yield (large group, very ample);

Group II: low MCA with high coagulation times, poor coagulation properties as for micellar aggregation rates, high level of non-specific PA, with a good performance relating cheesemaking yield;

Group III: Intermediate MCA and low coagulation time, high micellar aggregation rate, firm curds with good quality, high level of nonspecific PA, with good cheesemaking yield indicators;

The samples from **Group IV** appear isolated by a very weak MCA and low micellar aggregation rate, however, they demonstrate interesting coagulant properties.
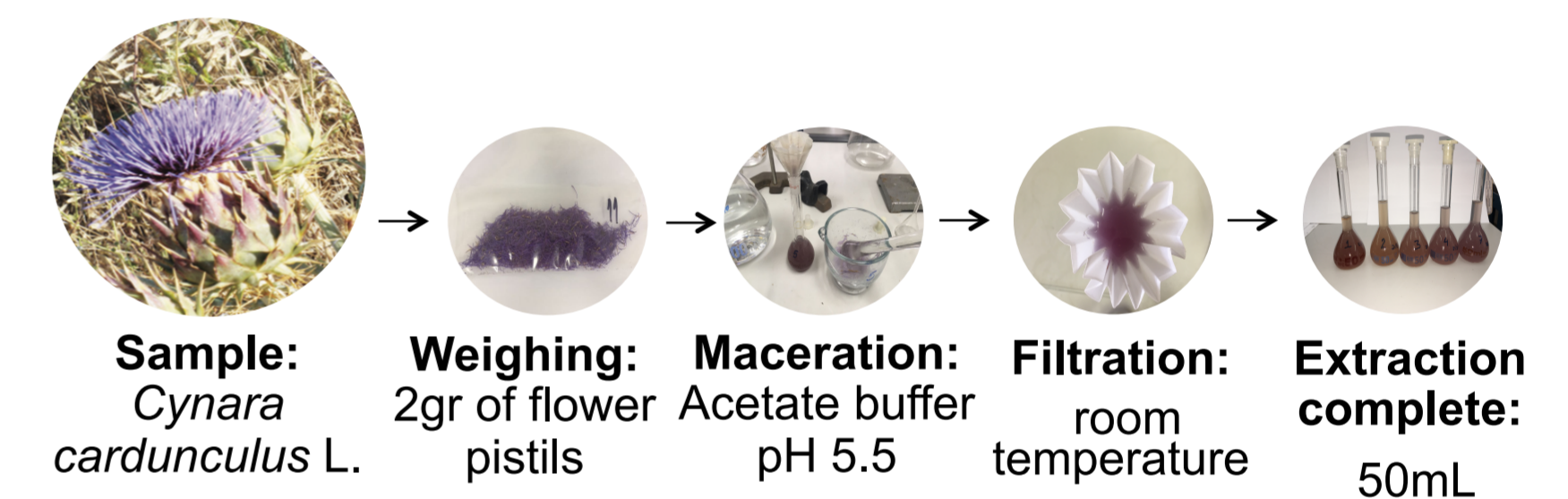
Introduction

Free flower picking

C. cardunclus L. coagulant - PDO cheeses

High rate of uncertainty in cheesemaking

Characterize, Evaluate & Compare - potential of cardoon flower populations from the Alentejo region

Materials and Methods

Sampling:
- 21 different cardoon flower populations;
- Alentejo region, Portugal;
- 2 successive flowering seasons: 2016 / 2017.

Cynara cardunculs L. coagulant extract preparation:

Sample: *Cynara cardunculus* L.
Weighing: 2gr of flower pistils
Maceration: Acetate buffer pH 5.5
Filtration: room temperature
Extraction complete: 50mL

Technological roperties evaluated:

- Milk Clotting Activity (MCA): (IDF 199 / ISO 23058: 2006)
- Monitoring of enzymatic coagulation: Optigraph (Alves *et al.*, 2004; Martins et al., 2009)
- Proteolytic activity (PA): (Gomes *et al.*, 2018)
- Potential cheesemaking yield: (Remeuf *et al.*, 1989; Martins *et al.*, 2009; IDF 4/ISO 5534: 2004).

Statistical analysis :
✓ Multivariate exploratory techniques (*Statistica*™) based on 13 parameters:
- Principal component analysis (PCA);
- Hierarchical cluster analysis (HCA).

Conclusions

This work confirms the **variability in the characteristics of the cardoon flower from different populations of the Alentejo region.** It was possible to observe the grouping of populations into 4 groups, with one of them including about 50% of the samples.

For 6 of the 12 populations sampled in both years, the technological properties of the cardoon flower were not sufficiently different to discriminate the samples regarding to the year.

Different authors have registered a **wide morphological variability in *Cynara cardunculus* plants** and this work confirms the technological properties variability of the different populations from the Alentejo region, which **may eventually contribute to the cheese quality or typicality through the influence in cheesemaking process**.

References

- Alves SMP, Martins APL, Mourato MP, Vasconcelos MM, Fontes AML. 2004. Effect of clotting agent on coagulation properties of sheep milk. *Proceedings of the International Symposium "The Future of the Sheep and Goat Dairy Sectors"*, FIL/IDF-CIHEAM, Zaragoza (Spain), 28-30 October, 278-279.
- Conceição C., Martins P., Alvarenga N., Dias J., Lamy E., Garrido L., Gomes S., Freitas S., Belo A., Brás T., Paulino A., Duarte M.F. 2018. *Cynara cardunculus*: Use in cheesemaking and pharmaceutical applications. In: *Technological Approaches for Novel Applications in Dairy Processing*. Nurcan Koca, IntechOpen, DOI: 10.5772/intechopen.76530.
- Gomes S., Belo A.T., Alvarenga N., Dias J., Lage P., Pinheiro C., Cruz C., Brás T., Duarte M.F., Martins A.P.L. 2018. Characterization of *Cynara cardunculus* L. flower from Alentejo as a coagulant agent for cheesemaking. *International Dairy Journal*. DOI: 10.1016/j.idairyj.2018.09.010
- Martins APL, Belo AT, Vasconcelos MM, Fontes AL, Pereira EA, Belo CC. 2009. Characterization of production system of Niza cheese (PDO): Effect of sheep breed on milk composition and coagulation properties. *Options Méditerranéennes*, Series A, 91, 221-226.
- Remeuf F, Lenoir J, Duby C., 1989. Étude des relations entre les caractéristiques physico-chimiques des laits de chèvre et leur aptitude à la coagulation par la présure. *Lait*, 69, p. 499-518.

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