INSTITUT AGRICOLE RÉGIONAL

TYPICALP

MILK PROTEIN POLYMORPHISMS OF AUTOCHTHONOUS AOSTA VALLEY CATTLE BREEDS

Mathieu MERLET, Luca VERNETTI-PROT, Sabina VALENTINI

Institut Agricole Régional – Reg. La Rochère 1/A – 11100 Aosta (Italy)

INTRODUCTION

Cow's milk proteins are encoded by highly polymorphic genes characterized by several mutations which result in different allelic variants. Each allelic variant has different possible effects on cheese-making properties and on human health. β-casein A1-A3-B, k-casein B and β-lactoglobulin B are supposed to influence milk cheese-making properties by increasing cheese or milk yield, by varying chemical parameters, by having small casein micelle size, and by influencing rennet coagulation time (RCT) and curd-firming rate (CFR). Furthermore, β-casein A2-A3-I are supposed to have beneficial effects at the gastrointestinal level and they produce lower amount of BCM7, an oppioid peptide related to potential negative health effects (1-5).

AIM OF THE STUDY

Aim of this study is to carry out, for the first time, a protein allelic variant characterization of Aosta Valley cattle breeds (Valdostana Pezzata rossa - VRP, Valdostana Pezzata nera - VNP, Valdostana Castana - CAS) and to perform a comparison with similar cattle breed (Hérens - HER, Blanche -BLA) coming from Canton Valais (CH) and other data present in literature.

MATERIAL AND METHODS

A LC-MS method (6) (Fig.1) was applied to profile the main milk proteins genetic variants from Aosta Valley autochtonous cattle breeds and Canton of Valais breeds showing the presence of all the most diffused allelic variants present in literature (Fig.2). Genotypes obtained have been related to chemical parameters of each analyzed cow in order to investigate the influence of allelic variant on cheese-making properties.

Fig. 1 Sampling, sample preparation and LCMS analysis

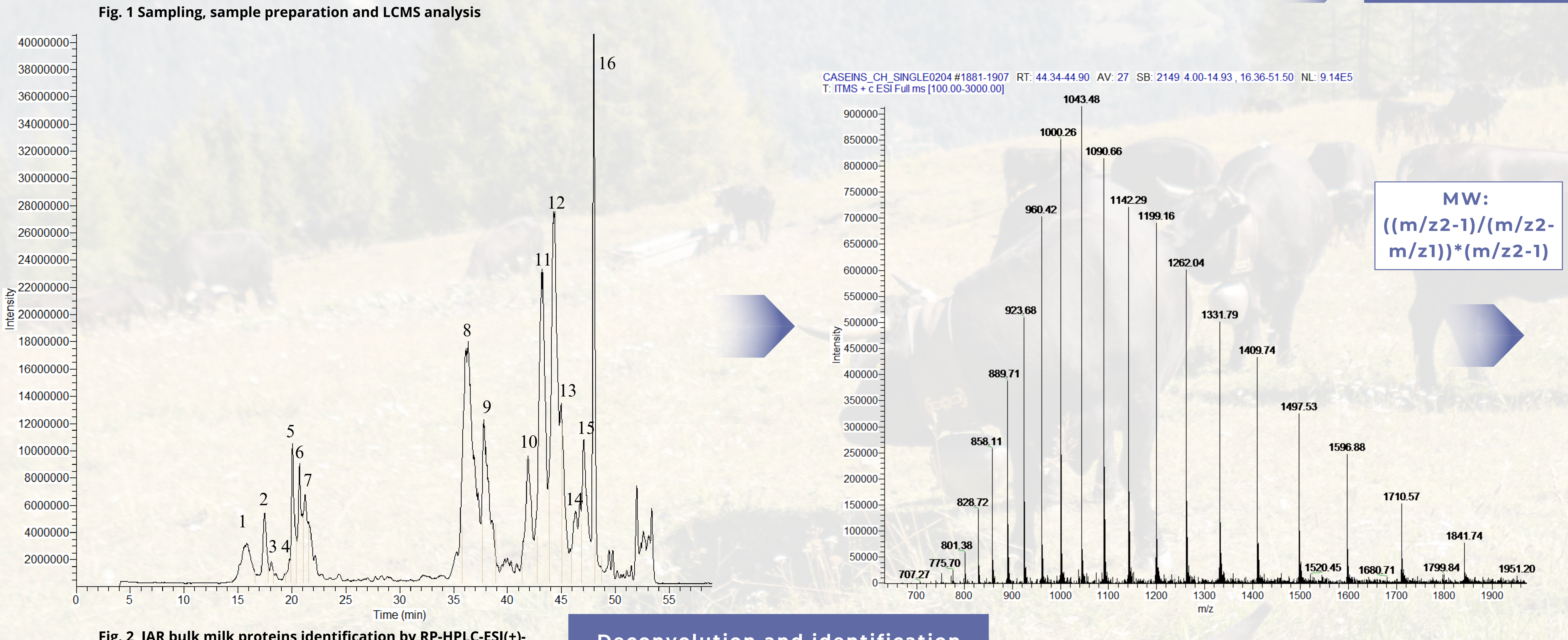

Fig. 2 IAR bulk milk proteins identification by RP-HPLC-ESI(+)-MS and β-casein A2 mass spectrum

Tab. 1 Allelic frequencies in Aosta Valley and Canton of Valais breeds compared to word mean value (green: positive value; red: negative value)
* mean value calculated using literature data from 2010 to 2023 belonging to 83 different breeds

Allelic variant	VRP	CAS	VNP	HER	BLA	world*
β-CN A1	0,21	0,06	0,13	0,04	0,27	0,32
β-CN A2	0,62	0,62	0,56	0,53	0,64	0,62
β-CN I	0,13	0,10	0,06	0,19	0,05	0,07
β-CN B	0,04	0,22	0,25	0,24	0,04	0,05
k-CN A	0,35	0,48	0,65	0,53	0,55	0,63
k-CN B	0,65	0,52	0,35	0,5	0,39	0,32
k-CN E	0,00	0,00	0,00	0,02	0,06	0,08
β-LG A	0,30	0,35	0,34	0,41	0,44	0,46
β-LG B	0,70	0,65	0,66	0,59	0,56	0,54

Allelic variant frequencies

RESULTS

VRP breed shows quite high frequencies (Tab. 1) of β-casein A2 and I, and low frequencies of β-casein A1 and B suggesting that this milk is suitable to be used as drinking milk. On the contrary, high frequencies of β-casein B, allelic variant considered as risk factor for human health, are present in VNP, CAS and HER.

As far as k-casein is concerned, allelic variant B, the most suitable for cheese-making, is the most diffused in VRP while allelic variant A in VNP, HER, BLA and CAS breeds. In the case of HER and BLA there is also E variant which is related to a worsening in cheese-making properties. Finally, β-lactoglobulin most diffused allelic variant for all breeds is B.

Anyway, no statistical significant differences have been highlighted ($p > 0.05$) in the correlation between protein and genotypes BB of k-casein and β-lactoglobulin (Fig. 3). However, further analyses are needed.

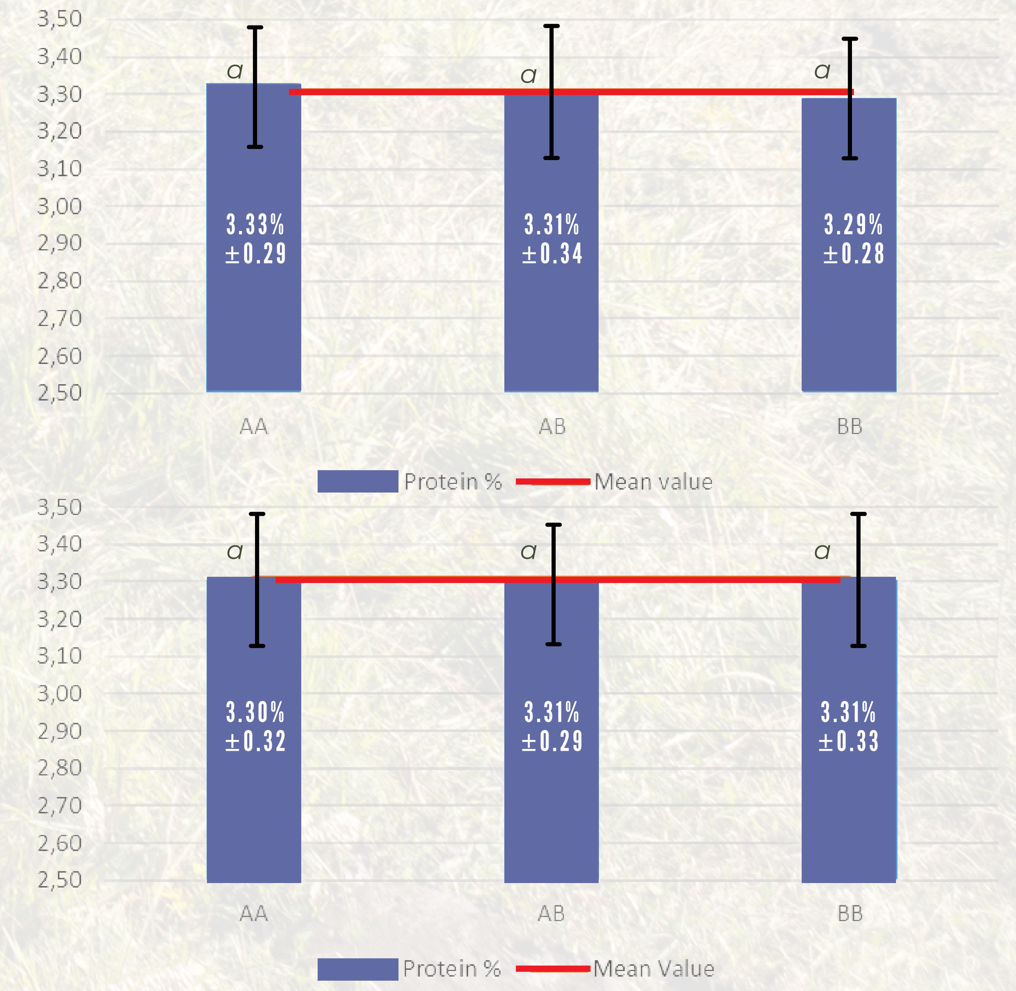

Fig. 3 Correlation between k-casein and β-lactoglobulin BB and protein content in milk

CONCLUSION

- RP-HPLC-ESI(+)/MS analysis is very effective for milk protein polymorphisms determination
- High frequencies of k-casein B, β-lactoglobulinB and β-casein A2 especially for VRP
- High diffusion of β-casein A2A2 genotype is important to valorize Aosta Valley cattle breeds milk hypothesizing to produce A2 drinking milk
- High diffusion of k-casein BB and β-lactoglobulin BB genotype can lead to a potential increase in cheese yield

REFERENCES

1. M. Marković, D. Radonjić, M. Dokić, A. Kandić, B. Marković. Agric. For. 67(3), 61 (2021), https://doi.org/10.17707/AgricultForest.67.3.05
2. S.I.S. Kay, S. Delgado, J. Mittal, R.S. Eshraghi, R. Mittal, A.A. Eshraghi. J. Nutr. 151(5), 1061 (2021), https://doi.org/10.1093/jn/nxaa454
3. M. Giribaldi, C. Lamberti, S. Cirrincione, M.G. Giuffrida, L. Cavallarin. Front. Nutr. 9, 1art. 842375 (2022). https://doi.org/10.3389/fnut. 2022.842375
4. M. Kaplan, B. Baydemir, B.B. Günar, A. Arslan, H. Duman, S. Karav. Front. Nutr. 9, 1 (2022), https://doi.org/10.3389/fnut.2022.935344, art. 935344
5. M. De Vasconcelos, L. Oliveira, J. Hill, A. Vidal. Foods 12(3151), 1 (2023), https://doi.org/10.3390/foods12173151
6. G. Miranda, L. Bianchi, Z. Kuprova, P. Trossat, P. Martin. Food Chem.: X 5, 1 (2020), https://doi.org/10.1016/j.fochx.2020.100080

ACKNOWLEDGEMENTS

This work was financially supported, through TYPICALP project, by European Union, European Regional Development Fund, Italian State, Swiss Confederation and Cantons co-financed operation, within the framework of the Interreg V-A Italy-Switzerland Cooperation Programme