DRY CURED SHEEP/LAMB MEAT: NORWEGIAN BIRKEBEINER "FENALÅR" COMPARED WITH SHEEP PASTRMA FROM BOSNIA & HERZEGOVINA AND MONTENEGRO

B. Egelandsdal[1*], S. Stojković[2], V. Grabež[1], M. Bjelanović[1], G. Vučić[2], A. Martinović[3], Pallin, E.[4], B. Markovic[5] & P. Berg[6]

[1] Department of Chemistry, Biotechnology and Food Science, Norwegian University of Life Sciences, Ås, Norway
[2] Department of Food Technology and Biotechnology, University of Banja Luka, Bosnia & Herzegovina
[3] University of Donja Gorica, Faculty of Food Technology, Food Safety and Ecology, Donja Gorica bb, 81000 Podgorica, Montenegro
[4] Nortura Tynset, Meierigata 3, 2500 Tynset
[5] University of Montenegro, Biotechnical Faculty, Department of Livestock Science, Podgorica, Montenegro
[6] Nortura SA, Postboks 360 Økern, 0513 Oslo

*bjorg.egelandsdal@nmbu.no

Abstract – Traditional dried sheep products from Western Balkan (WB) were compared with a commercial Norwegian (NO) dry cured sheep product (Birkebeiner "fenalår"). The methods used to compare the samples were: volatile compound analysis by Gas Chromatography- Mass Spectroscopy and sensory profiling. Dried products were characterized by 30 different volatile compounds. Most of these volatiles were in higher amounts in the WB product. The components were from smoke, lipid degradation and derived lipid degradation products as well as microbial metabolites. Both types of hams were described as salty, but the NO hams got higher scores for the sensory attribute matureness despite their saltiness and lower amount of volatiles.

The WB products were, in average, more acid. This could suggest that the salting step influenced bacterial growth inducing desirable or undesirable traits.

I. INTRODUCTION

A traditional way of maintaining sheep production sustainable has been the production of dry-cured sheep products. There is presently a general interest in the traditional processing methods both to stimulate documentation of unique quality characteristics and market advantages, but also to identify processing method that will make it easier to sell sheep meat, a less sought after commodity from lamb meat and sheep milk production.

Parts of Norway and parts of Western Balkan are mountain areas and best suited for small ruminants. These two regions have developed their dry cured sheep/ lamb production methodologies completely independent of each other and also use different breeds. Within the Balkan Peninsula the primitive Pramenka breed and its strains, are raised [1]. Pramenka is an indigenous sheep breed that is well adapted to the often unfavorable growing conditions in the mountain region of Balkan. Norway's dominant White Sheep breed is a relatively new breed, made by crossing of several local sheep breeds (Dala, Rygja and Steigar) and Texel breed. It was defined as a separate breed in 2000-2001 [2].

Compared to the many papers dealing with dry cured pork ham there is little information about dry-salted (cured) sheep/lamb meat production. The aim of this study was to compare the sensory properties and occurence of volatile compounds in dry salted ham products produced in Montenegro (MN) and Bosnia & Herzegovina (B&H) with the Norwegian commercial sheep product Birkebeiner "fenalår".

II. MATERIALS AND METHODS

Three different dry salted products were used:
1) Sheep ham from Norway (NO); 2) Pastrma from Bosnia & Herzegovina (B&H) and 3) from Montenegro (MN).

Table 1 Dry salted Birkebeiner "fenalår" (NO) and *Pastrma (*B&H & MN)

Process. step		NO *Birkebeiner*	MN and B&H *Pastrma*
Salting	Days	2	7-21
	T (^{0}C)	4	4
Smoking	Days	1	7-14
	T (^{0}C)	13	12-18
Drying	Days	50-60	7-15
	T (^{0}C)	13	7-15

Table 1 gives characteristics of the production. The products from NO and MN were produced by commercial companies while the products from B&H were produced by a local butcher. The target NaCl concentration of Norwegian Birkebeiner "fenalår" is 8.0 % w/w and for water activity 0.890. WB sheep hams should have water activity below 0.9. There is no present target for NaCl for WB hams.

Analysis of volatile compounds: These were analyzed by: 1) gas chromatograph 6890 (Agilent technologies Santa Clara, CA, USA), equipped with a 30 m x 0.25 mm i. D. DB - water fused silica capillary column; 2) Mass spectrometer with mass range of m/z 30 - 550 3) identification of compounds by NIST US Government library (NIST 05 Mass Spectral Library, Agilent technologies Santa Clara, CA, USA).

Sensory analysis: A trained panel of 8 persons evaluated: yellowness of fat, redness, marbling, fat firmness, hardness, aroma intensity, saltiness, bitterness, acidity, mature flavour and metallic flavour.

III. RESULTS AND DISCUSSION

The focus in this paper was to compare one type of Norwegian dry salted sheep product with similar products from B&H and MN. Table 1 indicates that there are differences in production methods between WB hams (from B&H and MN) and Norway. The processing procedures also vary substantial within WB. The more typical difference is a longer salting and smoking period for B&H and MN products than for the commercial salting/smoking step used in Norway. The smoking in the two Balkan regions are typically done in smoking houses where the product is also dried according to the temperature and relative humidity of the season (late winter). The salting step is also different; in Western Balkan (B&H) the hams are left to form brine for several days and no nitrite (valid in both B&H and MN) is added.

We have not included volatiles that identifies the products produced in B&H and MN as different as that will be described elsewhere [3].

Figure 1 is a web presentation of 30 volatiles that revealed a similar pattern in all Balkan products. It is apparent that the two Balkan products had higher prevalence of most of volatiles although exceptions existed.

Lipid degradation products: There were 4 compounds that stood out in the Norwegian ham production, namely 1,3 pentadiene (E), heptanal benzene and 1,2,4-benzenetricarboxylic acid, 1,2-dimethyl ester.

Benzene was more abundant in the NO ham, but the related compounds benzene, 1-ethynyl-4-methyl- and naphthalene were more abundant in WB hams as was other cyclic hydrocarbons. 2-cyclopentene-1-ones were more abundant in the Western Balkan production process. The formation of these compounds are not always clear but could be formed by the reaction between aldehydes from lipids, and they represent more mature lipid degradation products. Also 1-hydroxy 2-propanone was mostly present in WB products and this product can also originate from a previous reactive aldehyde that may originate from degraded lipids. Butanoic and propanoic acids were higher in WB hams than in NO hams.

Degradation components from beech chips: The WB products were more abundant in smoked components. 2(5H) furanone and 2-methoxy 4 methyl phenol were typical degradation product from wood and was only found in WB products. The NO sheep ham products are smoked mildly in modern cabinets, if smoked at all.

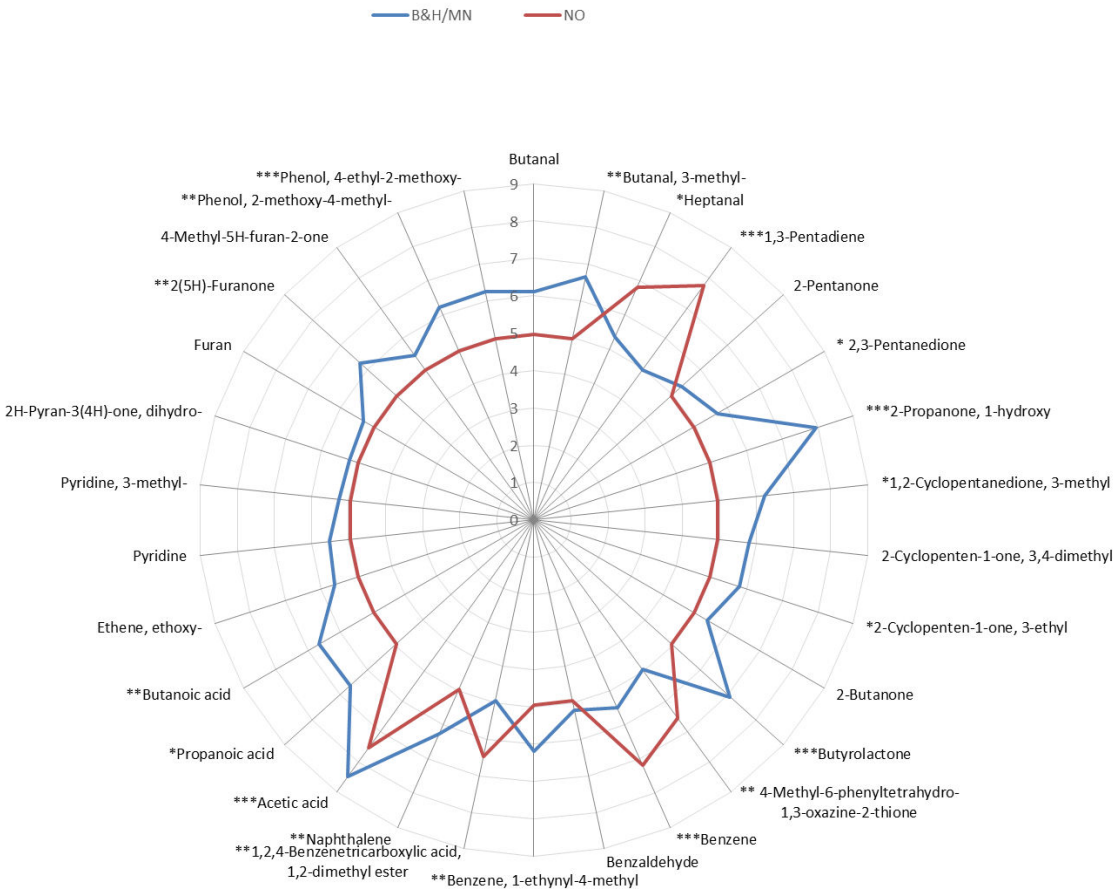

Figure 1. Volatile compounds (log area) of dry-cured sheep hams from Montenegro (MN)/Bosnia & Herzegovina (B&H) and Norway (NO).The stars in front of the names indicate significant differences between the 2 countries' ham productions (***=P<0.001; **=P<0.01; *=P<0.05, t-tests). Some volatiles have no indication of significance; such compounds were only found in either hams from Norway or in hams from Western Balkan with a level closed to detection treshold (*e.g.*set at log area equal to 4.95).

The results of the sensory analysis are shown in Fig. 2. The WB products tended to have more yellow fat, but the yellowness also varied more than in the NO product. The WB ham fat was less firm.

The NO product obtained higher scores for marbling and for redness. The latter may be due to the fact that nitrite was used during salting in NO and this may hide the fact that WB production generally uses elder animals that usually give a more intense colour. The assessors described both products as quite red/dark since the scores were up to 8 (Fig. 2).

The WB product was harder than the NO product (muscle part). This can be due to lack of fat in combination with less control of the relative humidity during the smoking/ drying step as this step relies on the outdoor humidity.

Despite the fact that the WB product had more smoke volatiles and transformed lipid degradation products, the sensory assessor did not use the sensory attribute (total) aroma intensity to differentiate between the products (Fig. 2). No ham was identified as rancid by the sensory panelists despite the fact that lipid degradation volatiles were obviously present in both productions. On the other hand, the sensory panel assessed the NO ham as more mature (Fig. 2). There were only a weak correlation (R^2=0.33) between mature flavour and

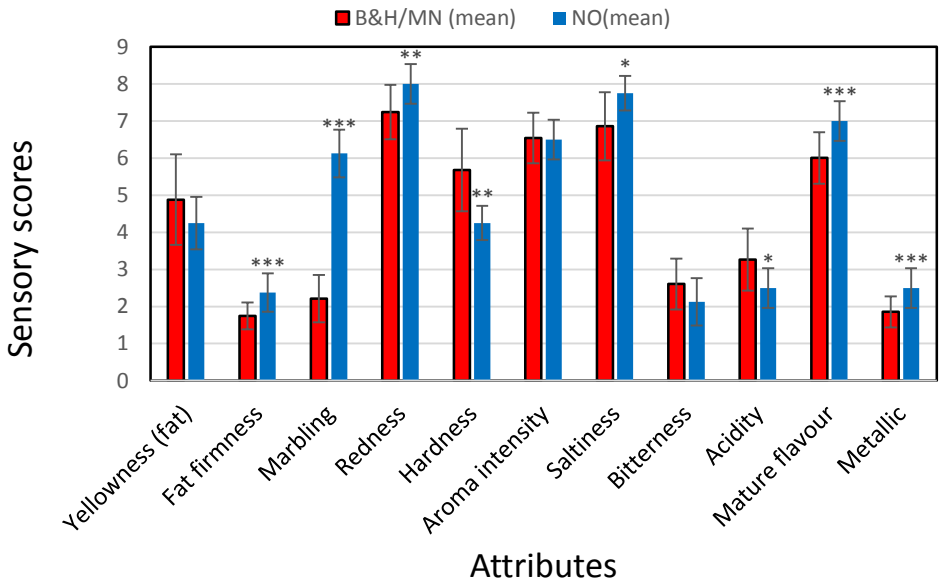

Figure 2. Sensory profile of dry cured sheep ham products from Montenegro (MN)/Bosnia & Herzegovina (B&H) and Norway (NO). The stars indicate significant differences between the two countries' ham productions (***=P<0.001; **=P<0.01; *=P<0.05, t-tests).

aroma intensity. The fact that both total aroma and mature flavour received high scores could indicate that both products had specific flavours, but that these flavours were difficult to differentiate.

The sensory analysis confirmed that the WB hams were more acid (Fig. 2). This seems only interpretable as the microbial metabolism being more intensive in WB hams. This may indicate a different microbial profile during the salting step in WB compared to NO products.

Bitter flavour is sometimes a challenge with sheep and lamb meat, but was here assessed as low, but it tended to be higher (P=0.08) in the WB hams.

Metallic flavour might be related to feeding differences and/or lipid degradation components [4]. The attribute was higher in Norwegian hams suggesting a different lipid degradation/ripening process.

These sheep hams were all regarded as salty. Western Balkan products varied more in salt content than Birkebeiner "fenalår" (Fig. 2) but only a few (out of 30) WB sheep hams scored higher in saltiness than the Norwegian ham.

IV. CONCLUSION

The WB dry cured sheep ham had more volatile compounds, were less salt and scored less for the sensory attribute mature flavour.

ACKNOWLEDGEMENT

The work was supported by The Norwegian HERD/Agriculture program to Western Balkan (project no. 19028). The activity is also linked to Nortura's project: "Tasty products from lamb and sheep".

REFERENCES

1. Mitić, N. (1984). Ovčarstvo, Zavod za udžbenike i nastavna sredstva,, Beograd, 1-504.
2. Boman, I. A., Klemetsdal, G., Nafstad, O., Blichfeldt, T., & Våge, D. I. (2010). Impact of two myostatin (MSTN) mutations on weight gain and lamb carcass classification in Norwegian White Sheep (Ovis aries). Genetic, selection evolution: GSE. 42: 1-7.
3. Stojković, S., Grabež, V., Egelandsdal, B., Bjelanović, M., Mandić, S. Vučić, G. Martinović, A. & Velemir, A. (2014). Comparison of the volatile profiles and sensory properties of the Western Balkan sheep *Pastrma* produced traditionally and under controlled industrial conditions**.** *In preparation.*
4. Fisher, A.V., Enser, M., Richardson R.I., Wood, J.D., Nute, G.R., Kurt, E., Sinclair, L.A. & Wilkinson, R.G. (2000). Fatty acid composition and eating quality of lamb types derived from four diverse breed production systems. Meat Science. 55: 141-14.