PS7.07 The influence of grazing time on Angelica archangelica on volatile compounds and sensory quality of meat from pasture lambs 315.00

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Abstract—The influence of finishing traditional grazing lambs on fields of Angelica archangelica on volatile compounds, fatty acids and odour and flavour of cooked meat was studied. 18 lambs were divided into 3 equal groups. One grazing on traditional grassland pasture, one grazing for 3 weeks and one grazing for 6 weeks on Angelica pasture. The lambs were slaughtered at the age of 120-140 days. Quantitative Descriptive Analysis (QDA) was used to describe the sensory attributes of cooked loins with subcutaneous fat. Gas chromatography-mass spectrometry (GC-MS) and gas chromatography olfactometry (GC-O) were used to identify volatile compounds and describe their odours. Fatty acids were analyzed by gas chromatography (GC). Analysis of variance was used to study the influence of treatments on sensory attributes. Relationship between sensory attributes, volatiles and fatty acids was studied using principal component analysis (PCA) and Partial Least Square Regression (PLSR). Most part of the variation in sensory data (95.4%) was explained by the grazing or not grazing on Angelica. Meat of lambs that grazed on Angelica had spicy odour and flavour that correlated with high amount of α-pinene, β-phellandrene and octanal and C18:1 and C18:2 fatty acids while the meat of the control lambs that continued to graze on pasture had lamb meat and wooly odours and generally stronger odour and taste that correlated with high amounts of 2 butanone, 3-methyl-3-buten-1-ol and 3-hydroxy-2-butanone together with saturated fatty acids. Only small part of the variation (4.6%) was explained by how long the lambs grazed on Angelica. The results indicate that specific terpenoids, e.g. β-phellandrene and α pinene can be used as indicators of Angelica pasture. The results strongly indicate that grazing traditional grass pasture lambs on Angelica fields changes the flavour of the meat. The study confirms that the Angelica meat is unique and this can be used in the marketing of the meat.

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Index Tems- Lamb, Angelica archangelica, volatiles, flavour

I.INTRODUCTION

Analysis of volatile compounds by GC-MS has been used in many studies to differentiate between diets of lamb and to authenticate the meat (1). Meat from grass pasture lambs has compounds like long-chain alkanes, C7 aldehydes and 2,3-octanedione while meat of concentrate fed lambs has more of short-branched and non-branched acids and methyl ketones (2-3). 2,3-Octanedione and 3-methylindole (skatole) are indicators of pasture diets. Sheep meat odour/ flavour are linked to the branch chain fatty acids, and are probably intensified by 3-methylindole and alkyl phenols (3). 3-Methylindole is stable while 2,3-octanedione is reduced if lambs are finished on concentrates (4). Little has been documented about the effects of finishing lambs on pastures with cultivated “spicy” herbs. Trials have started is Iceland of grazing lambs on cultivated fields Angelica archangelica in order to produce meat with distinct flavour (Figure 1). Figure 1. Sheep in a Angelica archangelica pasture Angelica archangelica spp. Archangelica belongs to the umbelliferous family Apiaceae and has a strong aromatic odour. The main volatile components of A.archangelica are monoterpene hydrocarbons such as α-pinene, β-phellandrene, δ-3-carene, p-cymene, 8.4% limonene and sabinene (5-7). They have been characterized sensorically as green,

terpenic, fresh, celeriac, and sweet (5). Angelica archangelica can be found all over Iceland. It is sensitive to sheep grazing and as grazing pressures are reduced and more farms become deserted, it expands rapidly into old hayfields and common rangelands. The use of angelica is still alive in Iceland, both as food, fodder and as herbal medicine (8). The aim of this study was to determine the influence of finishing traditional grazing lambs on a field of Angelica archangelica on volatile compounds, fatty acids and odour and flavour of cooked meat.

II.MATERIALS AND METHODS

18 lambs were in the experiment. They were divided into 3 equal groups. - lambs grazing on traditional pasture - lambs grazing for 3 weeks on Angelica pasture - lambs grazing for 6 weeks on Angelica pasture Figure 2. Sheep grazing on Angelica pasture The lambs were all slaughtered the same day at the age of 120-140 days. The lamb carcases were chilled down to 4°C for 24 hours and then cut into joints. The saddles were vacuum packed and aged for 5 days at 4°C. The saddles were deboned and loins with subcutaneous fat vacuum packed and frozen and kept at -24°C. Sensory analysis The loins were thawed overnight in a refrigerator at 4°C and put into steak bags and cooked to a core temperature of 64°C. After cooking they were placed for 5-10 minutes on a table before being cut into 2 cm slices that were presented to a trained panel of 10 people. Quantitative Descriptive Analysis (QDA) was used to describe the samples. An unstructured scale (left end = 0%, increasing intensity to the right end = 100%) was used with a defined sensory attribute vocabulary, describing odour and taste. The vocabulary for the products was developed and tested for comparable products in 3 training sessions. 14 odour and taste attributes were selected. Analysis of volatile compounds Volatile compounds were collected from pooled sample of loins with fat by a purge-and-trap sampling prior to gas chromatography mass spectrometry (GC-MS) or solid phase micro extraction (SPME) prior to gas chromatography olfactometry (GC-O). GC-MS and GC-O analysis were done as described in Jónsdóttir and others (9). Fatty acid analysis Fatty acid analysis was done according the GC official methods AOAC 996.06 and AOCS Ce 1f-96 Statistical analysis The program Fizz was used in planning, executing and analyzing the data of sensory analysis. Analysis of variance(GLM - General Linear Model and Duncan's test were carried out in NCSS 2000 (NCSS, Kaysville, Utah, USA) to study the differences between treatments in the amounts of volatile components. The relationship between treatments, volatiles, fatty acids and sensory attributes was studied using Principal Components Analysis (PCA), Partial Least Square Regression (PLSR) í UnScrambler 9.5 (CAMO AS, Trondheim, Norway).

III. RESULTS AND DISCUSSION

Sensory analysis The results of the sensory analysis are in Table 1. The greatest differences were found in odour attributes. There were more spicy odour and less woolly and fatty odour of the meat of the lambs grazing on angelica than of the meat of lambs grazing on traditional pasture. Meat of lambs grazing for 6 weeks on angelica fields had the least lamb meat odour and off odour, but the difference between the control and meat of lambs grazing for 3 weeks on angelica was small. But the difference in odour between the 3 weeks and 6 weeks group was on the whole rather small. The only significant difference in taste was in spicy taste where the angelica groups scored higher than the control group. Values for fat, wool and lamb meat taste were highest in the control group but the differences were not statistically significant. Table 1. The influence of grazing lambs on Angelica archangelica on odour and flavour attributes of cooked meat The results of the PCA of the sensory analysis data are displayed in Figure 2. The most part of the variation (95.4%) can be explained by the grazing or not grazing on angelica. Meat of pasture lambs that have grazed for 3 or 6 weeks before slaughter on angelica field has spicy odour and flavour while the meat of the control lamb that continued to graze on grassy pasture has lamb meat and wool odour and generally stronger odour and taste. Only small part of the variation (4.6%) can be explained by how long the lambs grazed on angelica pasture. Figure 3. PCA plot of sensory attributes of cooked meat and grazing treatment of lambs Key odour and volatile compounds The main odours identified by GC–O were derived from lipid oxidization described for example as grassy, boiled potato, mushroom and fatty like odours. The most abundant volatile compounds were aldehydes but the main difference between groups was in the amount of ketones. The most interesting difference was in the concentration of terpenoids but the amount and number of terpenoids increased with increased time on

angelica pasture. These are compounds like camphene, β-phellandrene, 3-carene, limonene and α-pinene that can contribute to camphor, turpentine, spice, and pine odours. The results indicate that specific terpenoids, e.g. β-phellandrene and α pinene can be used as indicators of angelica grazing. To study the correlation of the key volatiles and fatty acids with sensory data a PLSR model was calculated to predict the sensory scores of flavour and odour attributes based on GC–MS data and fatty acid composition. The first two PLSR component (Fig. 4) explained 69% of the x-variables (key volatiles and fatty acids) and 76% of the y-variables (sensory attributes). Spicy flavour and odour correlated with high amount of α-pinene, β-phellandrene and octanal and C18:1 and C18:2 fatty acids in the meat of lambs six week on Angelica. The reference group, with significantly higher wool and fat odours, was characterized with high amount of 2 butanone, 3 methyl-3-buten-1-ol and 3-hydroxy-2-butanone together with saturated fatty acid. PLSR model with volatile compounds as predictors for selected sensory attributes seems to explain the contribution of the volatile compounds to the spicy flavour and odour, wool, fat, and lamb meat odours that is characteristic for Icelandic lamb meat. Figure 4.Correlation loading plot from a partial least squares regression (PLSR) model based on volatile compounds and fatty acids as predictors and significant sensory odour and flavour attributes as response variables.

V. CONCLUSION

The results strongly indicate that grazing traditional grass pasture lambs on angelica fields changes the flavour of the meat. Both meat of lambs that grazed 3 or 6 weeks on angelica was different from meat of lambs grazing on pasture. The time of grazing on angelica had some influence. It decreased lamb meat odour. The analysis of volatile compounds confirms the difference between the angelica lambs and the pasture lambs. This method is normally used to differentiate between main diets like pasture versus concentrate. In this study it was however used to confirm that grazing on „spicy“ plants for few weeks before slaughter can change the flavour of the meat and in fact produce different kind of lamb meat. The study confirms that the angelica meat is unique and this can be used in the marketing the meat as a local product. Science can sometimes be useful in confirming what consumers already know. Chefs who tried and tasted the Angelica meat in a „chef of the year“ competition commented that the „the famous flavour in Icelandic lamb meat had almost disappeared“ and that the meat had a lighter colour and milder taste. They also welcomed the meat as an addition to the Icelandic cuisine and forecasted that within 5-10 years we would also have even more version of lamb meat with defined flavour of distinct grazing areas like „high mountain“, „berry“, and „seashore“.

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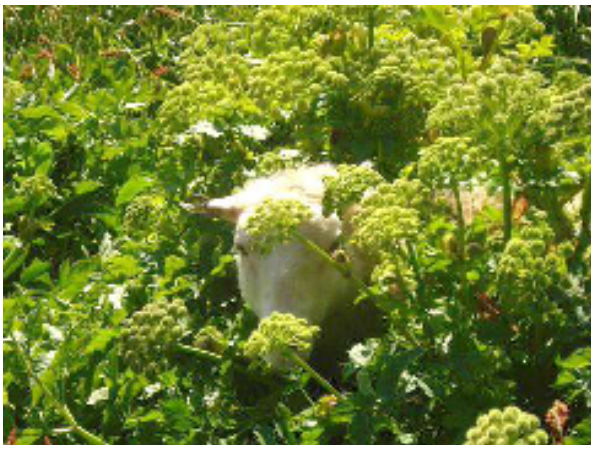

Figure 1. Sheep in a *Angelica archangelica* pasture

Figure 2. Sheep grazing on Angelica pasture

Table 1. The influence of grazing lambs on *Angelica archangelica* on odour and flavour attributes of cooked meat

	Pasture	**On angelica**		**p**
		3 weeks	**6 weeks**	
Odour of meat				
Spicy	27	37	35	<0,05
Lamb meat	52	48	46	<0,05
Wolly	26	15	16	<0,001
Off odour	12	9	7	<0,05
Odour of fat				
Fatty	36	30	29	<0,05
Sweet	29	28	29	
Flavour of meat				
Spicy	25	35	36	<0,01
Lamb meat	54	49	49	
Sour	22	23	20	
Liver/Game	43	40	39	
Wooly	14	10	11	
Iron	36	34	34	
Fatty	23	21	19	
Off flavour	6	4	5	

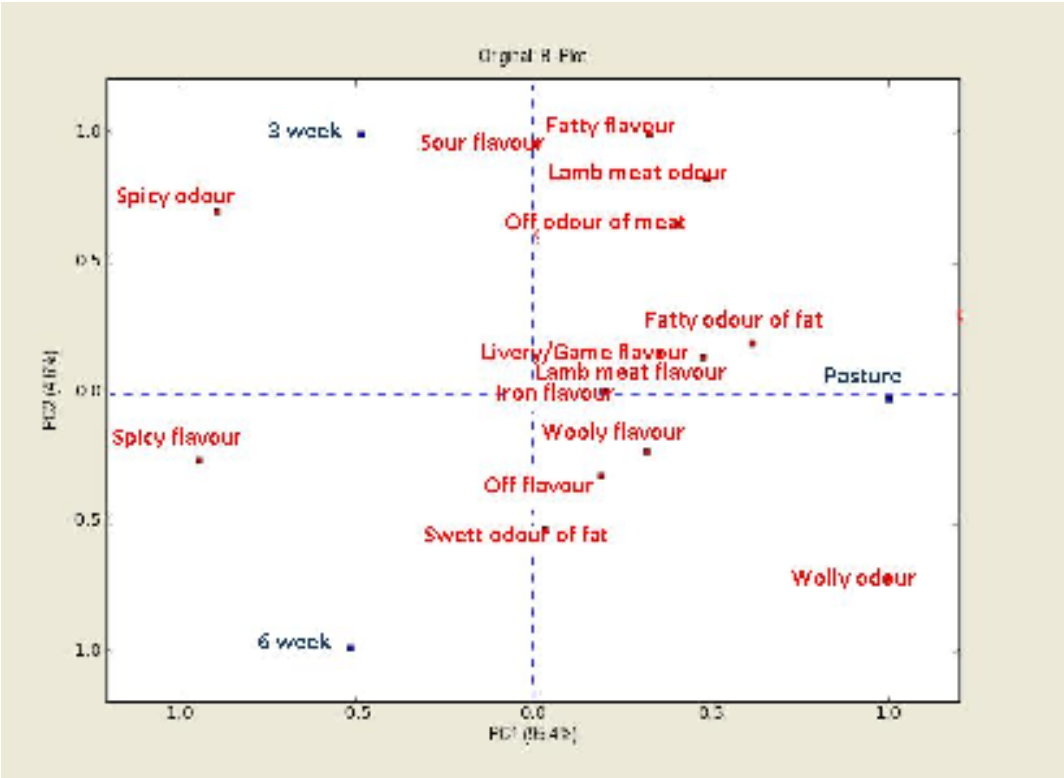

Figure 3. PCA plot of sensory attributes of cooked meat and grazing treatment of lambs

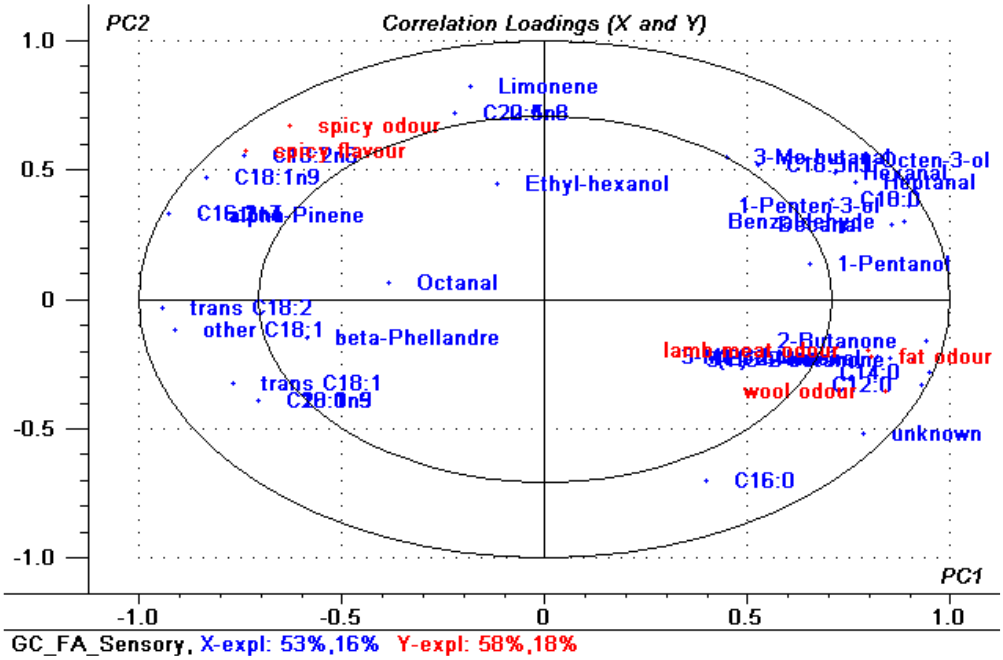

Figure 4.Correlation loading plot from a partial least squares regression (PLSR) model based on volatile compounds and fatty acids as predictors and significant sensory odour and flavour attributes as response variables.