THE COMPARISON OF UK LAMB FED CONVENTIONAL OR HERBAL PASTURES ON MEAT QAULITY

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Abstract

The effect of farming systems on the production and feeding of lambs was investigated with specific insight into meat quality. Lambs were selected for representation of their production system and by what is available to UK consumers. Meat quality can be affected by the production methods used, sample lambs were investigated using sensory evaluation, by use of the triangle test and proximate analysis to identify any quality or composition differences between lambs reared in different systems.

The sensory group was used to help generate any difference between the two sample lambs. Significant difference ($p<0.001$) in the Sensory Evaluation compared and supported additional literature, providing knowledge that the sample could be differentiated. Proximate Analysis was done to help support the results of any significance difference tried at Sensory level. Only protein resulted in significant difference ($p<0.001$), all other results could only be un-significantly identified to other research papers.

More economical and sustainable systems are far better at utilising the full potential of their production systems, this relying solely on their farming business and by the outsourcing of other farming products. However there are issues concerning the intensity of such systems, when competing in a volume led market.

1 Introduction

There is growing concern over how global food is going to be produced for an increasing population, it is estimated that by the year 2050 the population will have grown to nearly 9 billion people (EFFP, 2012). This is only an estimation so more significantly this could be more or less people who have needs to be nutritionally met, either way it is a catalyst to enforce change. Different farming methods will have to be used to provide enough food; this will have to be done on an intensive and volume basis. Mass production could have an effect on meat quality, varying and reducing the nutritional and sensory attributes of the meat. In order to fully evaluate the effects that production systems have on meat quality, sample lambs of extreme difference were required for analysis. Choosing a mixed herbal and flower fed lamb against a conventionally produced modern pasture and concentrate fed lamb, the study had something to compare. Meat is the main protein source in the human diet containing important proteins, vitamins, minerals and micronutrients which are essential for growth and development. It is estimated that 2 billion people in the world are malnourished; this is caused by limited access to resources and low incomes or areas suffering poverty (FAO, 2012).

2 Methods and Materials

Lamb samples was purchased from local farms in the Gloucestershire area, butchered and hung for one week. Two treatments were used, a Herbal fed and Conventionally fed lamb. The Topsides of leg was used in the Proximate Analysis and the Eye of Loin in used in the Sensory analysis. After the Topside was cut for the drip loss the sample was homogenised in the food processor ready for continued application and use in the rest of the Proximate Analysis.

2.1 pH

Samples at room temperature were used (+5*C). Using the whole topside from the leg of each sample lamb, as a whole piece before any cutting is made. Initially before any readings the pH and temperature probes were calibrated. Using a scalpel to make a small incision into the depth of the meat, being aware not to go all the way through, a 1” depth minimum incision was made with a sharp

blade to the areas, so the glass electrode and temperature probe would come into contact with the pH sensitive area (Warriss, 2000). After each reading the pH meter and the temperature probe were rinsed with de – ionised water before the next reading (Hoffman *et. al,* 2002). pH is recorded on the pH table using nine samples for each subject 9x3. These nine samples were evenly distributed 3 by 3 along the whole topside.

2.2 Drip Loss

The amount of drip from both samples was investigated. Using the topside from the leg of each sample lamb, the samples were removed from the cold store room at approximately (+5*C) and cut into 1.5cm diameter samples and placed into the filter paper ready to insert into the special centrifuge tube. The empty tubes were weighed and recorded before placement of the samples from the filter paper, followed by a weight recorded of each individual meat sample. The samples were raised in the tube to the 20ml line – adjacent to the bottom of the filter paper, thus allowing the expressed liquid from the samples to be collected at the bottom of the centrifuge tubes. Four samples were then placed into the centrifuged at 1000 RPM for 10mins using a refrigerated centrifuge. Maintaining a temperature of 5*C during centrifugation - set on the control panel. The last samples to be centrifuged had to have a dummy sample to balance the fourth centrifuge holdall to complete a full capacity test as with the other samples (Farag et. al, 2009). Immediately after centrifuge the drip loss percentage from the sample was measured.

2.3 Moisture

Weigh and record the weight of an aluminium tray with the sand, approximately 12 grams. Homogenise your sample, placing the whole topside into the food processor for two minutes until smooth and homogenous. No more than two minutes as your sample may over heat. Weigh samples at approximately 10g, recording exact weight of initial sample and position in the relevant trays, using the sand to mix into the sample helping to increase heat intensity throughout the cook stage. Clearly labelled and mark each sample. After placing homogenous sample on tray reweigh. The homogenous samples were roasted at 400*C, until the sample to be evaluated had reached little or no change in weight after timed measurements. This proving moisture to be removed from the sample, if little or no change was apparent so final weight was measured for calculation (AOAC, 1995).

2.4 Fat Extraction

Determination of Petroleum Ether Extractable Oil/Fat using the Gerhardt Soxtherm 2000. Samples were measured at 1gram and placed in the Soxtherm. After the samples had been measured the difference was evaluated and calculated between the machine via a meat free sample. The Soxtherm is designed to safely carry out solvent extractions, ensuring that there were no incompatible activities taking place whilst operating the Soxtherm (AOAC, 1995).

2.5 Protein Determination

A 2gram sample of meat is heated with concentrated sulphuric acid. This oxidizes the organic matter and converts the nitrogen to ammonium sulphate (kjeldahl digestion). The sample is then diluted with water and made alkaline with sodium hydroxide solution and the released ammonia containing the nitrogen is removed by distillation and determined by titration. Two blank samples containing only the onion skins that carried the other meat samples through the tube, would confirm that they did not affect the samples.

Kjeldahl tablets – catalyst (3.5g Potassium Sulphate) (0.4g Copper (II) Sulphate). Antifoam Tablets (0.97g Sodium Sulphate) (0.03g Silicone Antifoam). Low nitrogen concentrated sulphuric acid. Boric acid 4% with indicator (BDH) 0.1M HCl. Onion skin – Nitrogen free, added to blanks (B) to check free of, so no significance to samples. Were all used in the Kjedahl Method used in the AOAC, 1995.

2.6 Ash

Ash determination was done using the homogenous samples from the topside of the leg from each sample lamb. Measuring the initial pot weight, samples were weighed at approximately 2grams and numbers recorded. The samples were then placed into the oven at 500*C for 6hours. Samples were removed before allowing to cool, and reweighed (AOAC, 1995).

2.7 Sensory Evaluation

Triangle Method using the Difference Test:

Panelists were not trained, but prior to sample evaluation, panelists received instruction regarding the evaluation procedure in both written and verbal formats. The following written instructions were placed on the ballot: "Taste samples from left to right. Two of the samples are identical. Determine which one is the odd sample. You may re-taste samples. If no difference is apparent, you must guess". Verbal instruction prior to evaluation included reiteration of written instructions, as well as instructions to focus on flavour, evaluate samples one at a time, keep samples capped when not being tasted, proceed at own pace, and to cleanse the palate with water between samples (Theodore et. al, 2004).

(ABB, AAB, ABA, BAA, BBA) (Warriss, 2000).

Cook method of samples for sensory analysis:

The 'eye of lion' was used from the Herbal and Conventional fed lamb. Using a gas hob on the lowest temperature the meat samples were flash fried until golden brown for the same amount of time. Then in the same pan they were placed into the oven at 180*C for 20minutes, again placed inside the oven at the same time. Using a fan assisted oven reduced the need for any specific positioning inside. Before cutting samples were removed and the core temperature measured, reading 81/82*C and so far exceeding the required minimum of 70/72*C. Samples were sliced using the same knife, cleaned between samples and were measured approximately to 1" squares. Then the samples were foiled in their related category to rest for 10minutes, allowing time to alert the sensory panel of specific requirements and details. Serving then took place as quickly as possible onto paper plates and presented to the applicants. Results were then tabulated from this exercise.

2.8 Statistical Analysis

The differences between treatments were examined using statistical analysis, this analysis was performed using one way ANOVA, with the use of GENSTAT software (GENSTAT 13th Edition, Oxford, UK). Data was analysed differently using an analysis of variance (ANOVA), this was performed on each individual treatment of collected data. The proximate analysis were measured using the collected data from each individual method, if it was statistically different between samples then this will go forward in supporting the given hypothesis. The model used to analyse included the effects of all interactions to do with the laboratory exercise and the sensory evaluation.

3 Results and Discussion

3.1 Proximate Analysis

The level of difference between the results is small, reducing its significant difference in the analysis of GENSTAT. The pH results were so variant across individual samples that the analysis couldn't be used. Fat, Ash and Moisture however showed no significant differences, the results do show small comparable means which can identify and support the samples. The herbal lamb as an example has a higher fat content, reducing the level of protein it contains. Also the herbal sample had less drip due to the lower level of moisture it had compared to the conventional sample. Protein was the only differential result statistically in the laboratory exercise.

Table 4-1 shows the pH and degree centigrade measurements as an average, taken from the topside samples of the Herbal and Conventional fed lambs. Because of the fluctuation in results, these cannot be used to support the given hypothesis.

Table 4 1 Proximate Analysis – pH Averages

Mean/Average			
Herb pH	5.55	Herb *C	7.11
Conventional pH	5.57	Conv. *C	7.23

Table 4-2 shows the proximate analysis samples as an average for both sample lambs, although differences can be seen the Protein measurements were the only significant results when processed by GENSTAT. The protein ($p<0.001$) will support the given hypothesis by evaluating the effects of feeding regime on meat protein levels.

Table 4 2 Proximate Analysis – Fat, Protein, Ash and Moisture Averages

Lamb Sample	Fat	Protein	Ash	Moisture
Herbal	1.2	19.6	1.0	24.7
Conventional	1.0	20.8	1.1	25.0

Table 4-3 shows a reasonable difference in relation to the water holding capacity (WHC) of the meat. Although not significantly different research has shown that meat samples with a higher WHC cooks out better, resulting in a tender and moist meat when sensory evaluated (Hutchison et, al. 2012).

Table 4 3 Proximate Analysis – Average Drip Loss %

Lamb Sample	Drip %
Herbal	7.2
Conventional	8.3

Drip loss shows clear variation in the levels and capabilities of the meat to be able to maximise its WHC potential. Although not significantly different the distance between the average percentages of readings clearly state that the herbal fed lamb sample has a reduced drip loss percentage when compared to the conventional lamb sample. Proving that the herbal lamb has a better water holding capacity, supporting the sensory analysis results when evaluated in chapter 3.2.

The results are summarised in table 4-2 these are taken as an average percentage of the results in the laboratory work that didn't have large differences or fluctuations in the final results. Protein was the only analysis taken in the proximate analysis that showed there was a significant difference ($p < 0.001$) with regard to the type of feed consumed and the production system the animal endured. The fat to protein ratios in the lambs were correctly represented in the results to balance the quantities in the muscle, you would expect a higher fat content if the protein was lower as shown in the herbal fed lamb.

Studies show that it is important to associate feeding and animal breeds to the levels of FAs in the meat, so much so that nutritionists have also focused on the increasing of long chain FAs in the

animals diet, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) as these could have profound effects on the diets of red meat consumers (Demirel et, al. 2006). Further analysis of the fat content would have shown the relation between saturated and unsaturated fat levels, supporting whether the lamb sample would be healthier to eat or not in the given literature and thus supporting the consumer perception on quality towards the given hypothesis.

Mixed sward herbal leys have been shown to reduce worm burden on livestock reared in these conditions, due to the natural tannins and anthelmintic properties in the sward (Fraser et, al. 2007). Due to the nature of mixed sward grazing it is popular with organic producers who need to maximise yield and growth from naturally occurring micronutrients through a mixed sward ley compared to a modern ryegrass dominated sward. Studies such as Hutton et, al. 2011 show that there is improved live weight gain when comparing forage based systems. Mixed herbal swards significantly ($p<0.01$) improve yield over ryegrass dominated swards (Hutton et, al. 2011). Improving the grazing structure of the leys into a mixed herbal sward combined with legumes and ryegrasses alters the levels of composition in the meat. Studies show that meat composition levels are improved as a result of sward grazing and breed type (Hoffman et, al. 2003).

Herbal pastures have been studied to show improved sustainability and growth in lambs and other ruminants, due to the improved nutrient supply and anthelmintic properties, lamb growth (DLWG) is increased and health status improved (Ramirez – Restrepo and Barry, 2005). Meat quality is a result of healthier animals, breed has effect on the composition of intramuscular fats but overall quality is an effect of animal welfare, production and feeding system. If these elements are of improved efficacy and standard, animals going for slaughter are less likely to adhere to the effects associated with post mortem development from the derivatives of acute or chronic stress (Angood et, al. 2008).

Studies show that mixed sward leys tend to have higher protein than modern ryegrass prominent leys in the grazing season. Research undertaken by Sehested et, al. 2004 show that the protein content in the mixed sward paddocks were higher when compared to the ryegrass prominent leys. The digestibility of the organic matter in the paddocks were highest in the mixed sward ley, causing higher protein levels in the meat samples (Sehested et, al. 2004). When linking this to the protein levels associated in proximate analysis, this could be justification for why the herbal meat samples had higher levels when compared to the conventionally fed samples.

The levels of fat in lambs has been linked to artificially fed or naturally fed, when using more traditional methods to rear lambs, such as the herbal samples for this study can prove a higher fat to lean/ratio. This has been determined in the results but is not statistically different. Research identifies that the WHC of meat can be reduced when the animal endures stress during pre-slaughter and slaughter stages, although not significantly different in the analysis the un-significant result shows that the herbal fed lamb has a higher WHC than the conventional (Angood et, al. 2008).

3.2 Sensory Evaluation

The results summarised in table 4-5 shows the total number of correct and incorrect representatives in the sensory evaluation. The sensory evaluation required the taste panel to identify the odd sample in the difference test put forward to them. These results were then put together as a percentage and analysis was done using statistical analysis GENSTAT(13th ed.) showing a statistical difference ($p < 0.001$) between the odd samples measure, proving the herbal and conventional fed lamb samples to be differentiated by taste.

Table 4 5 Sensory Evaluation of Compiled Results

Total	Number of Responses	12
Correct	9	75%
Incorrect	3	25%

Stat P Value: Probability < 0.001 Significantly different

The differentiation between the samples were identified in most cases ($p<0.001$) there were significant results in determination of the lamb samples. Other studies show that feeding systems can result in different comparable results relating to sensory analysis, Hutchinson et, al. 2012 used deer fed on grass pasture or supplementary fed with grain. Results showed that the flavour strength of pasture fed animals was significantly lower than intensively grain fed animals (Hutchinson et, al. 2012). Relating to the difference sensory test provided for the given hypothesis of this study, a suggested reason why the panellist could identify the odd one out could be due to the flavour strength of the meat. Intensively reared lamb is suggested to taste stronger than extensively fed lamb (Burke, 2013).

It is important in the sensory analysis of meat to identify the texture and tenderness by the general feel in the mouth, although this study did not identify these attributes, comments in the Sensory Analysis were invited. These identified that the un-siginificant results leaned towards the panellists referring to the herbal lamb sample as tender and more moist in general cases. This supports literature to show that animals reared in less intensive systems on more forage and natural based diets had less chances of chronic stress, resulting in improved meat quality (Hutchinson et, al. 2012).

4 Conclusion

Generally production systems effect the meat quality of animals due to the intensity or extensity applied in that farming system. Intensive systems are provided to maximise output, these may become more extensively used as methods to produce larger quantities of meat globally for a growing global population. These systems are taking away a natural environment for the animal, being regimented and in some cases highly stressful. If these intense systems are managed correctly, with specific application towards good animal health and procedures the stress an animal may endure can be reduced. Precision methods of farming has the potential to improve the welfare of animals if used to improve the health and food safety enacted on the farm, this is due to the attention of detail that will undergo high assurance and welfare standards.

Extensive systems however reduce chronic stress on the animal due to the natural environment played in the production system. The animals can benefit from full attributes associated in the Five Freedoms, Defra and live a full and happy life. The reduction of handling required for these animals reduces stressors, the health status is improved and small ruminants such as sheep can thrive and improve DLWG by maximised nutrient rich forage. These forages are designed to utilise the gut pH and environment of the animal, mixed swards of herbs and flowers can be used to supply the animal with natural anthelmintic effects, reducing labour and the chances of worm resistance to modern medicinal families.

The use of mixed forage not only improves the level of natural welfare imposed on the animals being reared for meat but the methods of farming used generally are environmentally supportive to the farm. The roots and permanent status of permanent pastures will improve the soil structure on the farm, reducing likeliness of nutrient leaching through the soil. The farming system in place is also more in favour of sustainable methods, due to the natural and permanent status imposed on the forages grown.

Seasonal grazing is imputed to suit the growth and grazing times used for the animals. Sustainable methods of farming will improve the ability to provide food in the future, farming methods to support the environmental and conservation of the land will support the ecological requirement for the future survival of land use. Food grown in this way provides farmers with the ability to maximise profit on their carcasses, as the quality of the meat will be a key indicated to consumer choice.

Consumers want healthy and food safe sources of food in their diets, the reduction in meat quality means that the environment for pathogens to grow is increased. This ultimately affecting the quality of meat through PSE or DFD meats and the pathogens that grow will result in spoilage of the meat. This can cause more wastage due to the limited storage life and ability of the product, or potential health risk of pathogen growth on the meat causing human illness.

Meat quality is important to secure and identify, as the pressure imposed from the food industry to produce cheap meat and more of it will affect the quality sold to the consumers. Food safety and the outbreak of disease is the largest control that is required to enforce in the food industry, these can have large detrimental effects on producers, supplier alone. Such examples can be related to the last foot and mouth epidemic, a result of cheaper food sourcing to grow animals in a maximised system.

The results of this study have identified the main areas of quality that can affect overall quality of meat, these areas need to be controlled. Using specific production systems will ensure the sustainability of our food resources. Consumers are drivers for change and although wanting cheaper food resource, it is required that food safety and quality throughout the supply chain is key drivers for purchase. The composition of the meat in this study supports other research that the poorer the composition the reduced quality and status the meat will endure. Production systems do have an effect on the overall quality of the meat, future sustainability through ecologically secure methods, such as forage based farming systems are factors to consider when wanting improved meat quality and animal welfare status.

5 Acknowledgements

The authors wish to thank the support and use of the facilities at The Royal Agricultural College and to the local producers and butchers who aided in preparing the lamb samples ready for analysis.

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