EFFECTS OF THE DIETARY MILLET (*PANICUM MILIACEUM*) ON SOME QUALITY CHARACTERISTICS OF LIVER, *LONGISSIMUS DORSI* AND *SEMITENDINOSUS* MUSCLE ON PIGS

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Abstract

The purpose of this study was to evaluate the effect of 25% millet (Panicum miliaceum) as replacement of triticale on some quality characteristics of pig meat. Forty pigs Topigs hybrid (initial body weight 13.58 ± 0.37 kg) used in the trial for 30 days were assigned into two dietary treatments: control diet (M) and experimental diet (E, with 25% millet that replaces triticale from M diet). The pigs were slaughtered (n=3/group) at 81 ± 3 days (final body weight 32 ± 4.5 kg). The samples were taken from the liver, Longissimus dorsi (LD) and Semitendinosus (ST) muscle and analyzed for: pH, colour and texture profile. The pH value of the liver and texture profile of all the tissue samples from E diet were not statistically different comparing to the M diet. Pigs fed E diet had a significantly increased value of redness a in the liver (>17%) and in the ST (>45.5%) compared to M group. The liver yellowness b* was significantly higher (>53%) in the E group compared to the M group. For all tissue samples, the shear force was significantly affected in group E compared to the M group. In conclusion, the replacement of triticale with millet could be recommended for inclusion in pigs diets, without affecting pig meat quality.*

Key words: meat quality, millet, pork

INTRODUCTION

Pig meat due to the nutritional characteristics, particularly the proteins with high biological value and optimal amino acid composition, is easily and completely usable in human metabolism [20]. Moreover, the content of pig meat in vitamins (thiamine, in particular) and fats, especially, unsaturated fatty acids and cholesterol is similar to that of low-fat meats, lambs and poultry[18].

However, meat quality is influenced by multiple interacting factors such as breed, genotype, and the conditions under which the meat is produced (food). Also, pre-slaughter handling and stunning, slaughter method, chilling and storage conditions have a major contribution on meat quality parameters [4, 9].

In pig production, nutrition plays an important role in the productive potential of animals. If in the past the main objective in dietary formulations was to meet the animal's requirements to provide energy, protein, vitamins and minerals, it now relies heavily on improving the quality of meat such as tenderness, juiciness, color and lipid profile by maximize the nutritional potential of new nutritional sources [28,18,17].

Given the importance of nutrition in pig production and general aspects of meat in present, is a constant concern to replace some pigs' dietary ingredients that serve as major sources of energy and protein with cheaper ingredients, without affecting the development of animals and their products.

Searching for alternative nutritional sources is even more alarming among non-ruminants since feed price make up more than 65% from production costs [5] and cereals has increasingly been diverted toward

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human consumption and the corn-ethanol industry rather than to the pig sector.

In this context, millet (*Panicum miliaceum*), is a cereal with high content in protein (lysine, methionine and threonine), oil and gross energy value, being considered a valuable source both nutritionally and economically compared to other grain. [1, 6]. However, a limited number of studies have been conducted to evaluate the possibility of partially or totally replacing cereals grains with the millet in pigs diets [5, 24] and they concluded that dietary millet did not reduce performance (22.7 kg to 51.6 kg) or carcass characteristics (carcass yield, back fat thickness, loin eye area, fat/steak relation and ham yield). Thus, limited data are available on the effect of millet in growing pig's diets on quality carcass characteristics such as pH, colour and texture profile of different tissues.

Therefore, the purpose of this study was to evaluate the effect of 25% millet (*Panicum miliaceum*) as replacement of triticale on some quality characteristics of pigs tissues.

MATERIALS AND METHODS

Animals were treated in accordance with the Romanian Law 305/2006 for handling and protection of animals used for experimental purposes. The feeding trial was conducted on the experimental farm of INCDBNA Balotesti according to Law 43/2014/Romania, and experimental procedures were approved by the Ethical Committee.

Animals, diets and sampling

The experiment was conducted on 40 growing pigs (81 ± 3 days and a weight of 13.58 ± 0.37 kg), of commercial hybrid Topigs, maternal line format, from the crossing of two breeds Large White × Hybrid (Large White × Pietrain) and the paternal, of Talent, terminal boar mostly Duroc. For a period of 30 days, the animals were assigned into two dietary treatments (20 pigs/group): control group (M) that received a conventional diet based on corn, triticale and soybean meal, and the experimental group (E) which had a 25% millet content that replaced the triticale. The pelletized feed and water were given ad libitum throughout the trial.

At the end of experimental period the pigs (n=3/treatment, body weight 32 ± 4.5 kg) were slaughtered for samples collection. The *Longissimus dorsi* (LD), *Semitendinosus* (ST) muscles and liver samples were individually collected in vacuum-packed, labelled and frozen at −18°C until analysed.

Physical-chemical analysis of pork tissues samples

Physical properties determination

The tissues samples were analysed for physical properties (pH, colour, texture) at the Food Engineering Faculty, Ştefan cel Mare University, Suceava, Romania. Initially, the samples were thawed overnight (approximately 16 h) at 4 ± 1°C.

The pH of the tissues samples was performed using a portable pH Meter (HACK, Germany). Tissue samples (5 g) were cut into pieces and mixed with 5 ml of distilled water (tissue-water mixture). The pH of the tissue-water mixture was performed in triplicate according to SR ISO 2917: 2007.

The colour of tissues samples was instrumentally measured using a Chroma Meter CR-400 (Minolta Co. Ltd, Tokyo, Japan) calibrated with a white ceramic tile on D65 illuminate. The colour was expressed in the CIE L*a*b* colour system [7] Lightness (L*), redness (a*) and yellowness (b*) values. Values were determined on the fat-free surface area of the tissues. Each colour measurement was performed in triplicate for each sample, using different instrument orientations, and the average value was used for data analysis.

Textural properties analysis (TPA) of the pig tissues were measured using a texturometer (Perten TVT 6700). The double cycle compression was determined with a cylinder probe 20 mm diameter, stainless steel, which allows determination of firmness, springiness, resilience, cohesiveness, gumminess, and chewiness.

Statistical analysis

The data recorded were expressed as mean values and standard error of the mean (SEM). The data were submitted to variance analysis using the General Linear Model (GLM) of the SPSS program [27]. Differences were considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

The present study was performed in order to obtain information about the effect of dietary 25% millet on the quality of 2 type of muscle and liverof growing pigs.

pH

The degree of reduction of muscle pH and time after slaughter are depending on species, muscle type, and the preslaughter stress and has a significant effect on the meat quality [9, 13, 22, 25]. On the bases of these observations, it is likely that the ultimate pH in meat is reached at 5.3-5.8 in different times post mortem.

In this study, as shown in Table 1, the pH of the tissue samples was not affected ($p>0.05$) by the dietary treatment. The pH values of the LD and ST muscles obtained in our study are comparable to the results reported by other research [14,23, 29,30].

There are not significant differences between groups of animals regarding the pH of the liver. However, we noticed that the liver pH is higher ($p>0.05$) than the muscle pH. Although, there is limited data of the pH value for the liver, we noticed that the liver's pH values obtained in our study are comparable to those obtained by Tomovic et al. [30] but on different animal species.

Instrumental colour parameters

As shown in Table 1, in this study, the lightness (L*) value of the LD and ST tissue samples were not significantly affected by the dietary treatment. The values of L* obtained in the current study are close to those reported for LD by Furtado et al. [14] and Tomovic et al.[29].

In the present study the L* of the liver was significantly higher (14%) in group E compared to group M. Thus, the liver from the E group has the lightest colour. There is not much data about the range of pig liver colour. However, our results are comparable to those obtained by Tomović et al. [30]on goat liver.

As regards the contribution of redness (a*) to the pig colour, highly significant differences were reported in the ST and liver tissues. Thus, the ST muscle from group E has the value of a* with 45% ($p<0.01$) higher compared to group M, and the liver of E group was higher with 17% ($p<0.01$) compared to the M group.

Table 1 pH and colour parameters of pig tissues

Item	M	E	SEM	*P-value*
Longissimus dorsi				
pH	5.52	5.57	0.011	0.001
Colour				
L*	52.60	53.50	0.259	0.069
a*	1.21	1.25	0.064	0.777
b*	9.75	8.61	0.276	0.009
Semitendinosus				
pH	5.56	5.59	0.013	0.001
Colour				
L*	49.31	48.43	0.265	0.094
a*	3.24	5.94	0.606	0.001
b*	9.74	8.06	0.412	0.011
Liver				
pH	6.31	6.31	0.005	0.275
Colour				
L*	31.40	35.65	0.950	0.001
a*	7.28	8.69	0.345	0.007
b*	3.50	7.55	0.907	0.001

M: control group; E: experimental group; LD: *Longissimus dorsi*; ST: *Semitendinosus*; L* (Lightness), a* (Redness), b* (Yellowness); SEM: standard error of the mean; a,b Row means with different superscripts differ significantly at $P<0.05$.

The yellowness (b*) values of the tissues samples were all significantly affected by the dietary treatment. The LD and ST muscles, had lower b* values (13%, p<0.01 and 21%, p<0.01) in the E group compared to the M group. The LD and ST muscles are less yellow compared to the M group.

The dietary treatment increased the b* values of the liver with 53% (p<0.01) compared to the M group.

In our study the results for instrumental colour a* b* values of LD and ST are comparable to other research [2, 23].

From our knowledge, there is no data regarding the colour of pigs fed millet diets and slaughtered at a live weight of about 30 kg. The data obtained in our study are in agreement with the results obtained by Gil et al. [15], who fed pigs with conventional diets and tested the meat quality parameters depending on the genetic line. Thus, the Gil et al. [15] observed that the Landrace and Large White lines pigs had lower a* value and the meat was lighter (higher L*). Similar values, regarding the colour parameters (L*, a*, b*) in the *Longissimus* muscle of pigs from different origins, have been reported by other studies [3, 8, 12, 16].

Álvarez-Rodríguez [3], stated that the colour can be influenced by the breed, age, type of housing and diet. Moreover, Chang et al. [11] noticed that the significant difference in colour parameters of pig meat is due to different tissue and fiber types. *Longissimus dorsi* and *Semitendinosus* muscles can be defined as different muscle types according to their glycolytic or oxidative capacity. The type of muscle fibers responsible for differences in myoglobin content between muscles.

TPA

In meat processing, red and white muscle fibers condition certain very important qualities such as tenderness, succulence, texture and aroma [32].

In the present study, there were no significant differences in LD and ST muscle TPA parameters between groups (Table 2). However, as result of the TPA, it can be noticed that the LD and ST muscles from the E group have a lower value (p>0.05) of the hardness, gumminess and chewiness, compared to M group. Thus, we can say that muscle samples from E group are softer than M.

Table 2 Texture profile analyses (TPA) of pig tissues

Item	M	E	SEM	*P-value*
Longissimus dorsi				
TPA Parameter				
Hardness (g)	1431.0	763.5	241.6	0.203
Springiness (adm)	1.0	1.0	0.006	0.512
Resilience (adm)	3.0	2.4	0.228	0.215
Cohesiveness (adm)	0.4	0.4	0.007	0.153
Gumminess (g)	563.3	315.6	94.96	0.247
Chewiness (g)	563.9	315.6	95.23	0.247
Semitendinosus				
TPA Parameter				
Hardness (g)	1754.0	1641.0	119.20	0.726
Springiness (adm)	1.0	1.0	0.008	0.715
Resilience (adm)	3.6	3.6	0.0905	0.996
Cohesiveness (adm)	0.4	0.4	0.0431	0.835
Gumminess (g)	728.9	694.0	78.380	0.871
Chewiness (g)	729.4	695.4	78.105	0.874

M: control group; E: experimental group; LD: *Longissimus dorsi*; ST: *Semitendinosus* TPA: texture profile analysis; SEM: standard error of the mean; ^{a,b} Row means with different superscripts differ significantly at P<0.05.

Similarly, to our results, values of textural parameters of pig muscles were reported by Wiecek et al. [31] and Alonso et al. [2].

Contrary to our results, when a total of 380 pigloin samples were taken at 24 h post-mortem from pigs (Landrace×Yorkshire×Duroc) raised in the same farm under the same condition including the same feed, the TPA-parameters had lower values compared to other results [10].

However, there are evidence that the type of muscle and post-mortem proteolysis of myofibrillar proteins play an important role in texture characteristics of meat [26] and had a major impact on meat quality parameters.

CONCLUSION

In conclusion, the replacement of triticale with 25% millet did not influence negatively the quality parameters (pH, colour, and texture profile) of the pig. The tissues of pigs from the experimental group was characterized by a normal quality, and can be used for consumption. Therefore, further research is needed to determine the effect of millet on the meat sensory quality. Moreover, the replacement of triticale with millet based on meat quality parameters reported in this study can be used as an alternative grain in pigs diets.

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