MEAT SENSORY CHARACTERISTICS FROM PIGS FED WITH A SOLID-STATE FERMENTED APPLE POMACE AND AN ENZYMATIC COMPLEX

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Abstract – There are impacts of meat sensory quality on consumer purchase decision. The aim was to evaluate sensory characteristics of meat from pigs fed with a solid-state fermented apple pomace (FAP) and an enzymatic complex (Allzyme-Vegpro®; ENZ) treatments; *T0-0* (0%FAP-0%ENZ), *T0-0.1* (0%FAP-.1%ENZ), *T5-0* (5%FAP-0%ENZ), *T5-0.1* (5%FAP-.1%ENZ), *T10-0* (10%FAP-0%ENZ) and *T10-0.1* (10%FAP-.1%ENZ). Principal components analysis, sensory profile and, multiple comparison tests were developed using color, odor, flavor and texture descriptors. Raw meat from *T0-0* and *T5-0* was defined as pale, fresh, sticky, and yellow. From *T5-0.1*, as pale and sticky, from *T10-0* as red and fresh, and from *T10-0.1* as pale, fresh and meat odor. Meat from pigs fed with 5% of FAP was less red and paler ($P<0.05$) than meat from pigs fed without FAP, while meat from treatments with 10% of FAP was redder and more aqueous ($P<0.05$). Five and 10% of FAP and 0.1% of ENZ addition increased juiciness in cooked meat ($P<0.05$). Meat from pigs fed with 10% of FAP might have better appearance at sale point.

Key Words – Apple by-product, Meat, Pork quality.

I. INTRODUCTION

Due to the impact of meat sensory characteristics on consumer acceptance it is important to keep an equilibrated focus between technologic and sensory evaluation. Meat consumers have increased their knowledge about meat processing, and are more concerned for sustainability, animal welfare, food safety and the effects that meat inflict on their health [1,2,3]. They are dynamic and interactive between their needs and status. Jonsäll [4] considered that consumer demands could be based on sensory factors, physiologic status, culture and habits. Indeed purchase decision is based on price and sensory taste of meat [5]. Description of color, flavor, odor and texture characteristics will help to know the principal changes that are produced by feeding and production systems, and which are the most important to consumers [6,7,8,9,10]. To our knowledge there is a lack in scientific studies that have reported effects of feeding pigs with apple by-products and enzymatic additives; to improve digestibility, on sensory characteristics [11,12,13,14]. Further, as mentioned by Aaslying *et al*. [1] various characteristics on raw meat are evaluated by consumers at sale point. Because of this it is important to know if there are changes on meat sensory characteristics when FAP and ENZ are introduced in swine ration. The objective of this work was to evaluate sensory characteristics of meat from pigs fed FAP and ENZ.

II. MATERIALS AND METHODS

Longisimus dorsi muscle (LDM) from 24 Landrace x York pigs fed with different levels of FAP and ENZ *T0-0* (0%FAP-0%ENZ), *T0-0.1* (0%FAP-0.1%ENZ), *T5-0* (5%FAP-0%ENZ), *T5-0.1* (5%FAP-0.1%ENZ), *T10-0* (10%FAP-0%ENZ) y *T10-0.1* (10%FAP-0.1%ENZ), was dissected from the left half carcass 24 h *post mortem.* Later, a sample of 10 cm; at 12th rib level from each LDM was cut, vacuum packaged and stored at -20°C until their process. Four steaks; 1.5 cm thickness were cut, thawed for 24 h at 4°C and cooked until steaks reached 70°C. A sensory panel of 11 semi-trained judges developed a principal component analysis (PCA) to determine which descriptors best defined meat from different treatments. Descriptors for raw meat were color (red, pink, yellow and, pale), odor (meat, fresh and, rancid) and texture (soft, sticky, consistent and, aqueous), for cooked meat; flavor (meat, pig, fatty and, salty) and texture (fibrous, soft, elastic and hard). A sensory profile (SP) was developed considering the most significant descriptors using a non structured lineal scale with two anchor words (non salty, very salty). Finally a multiple comparison (MCT) test was developed on

cooked meat, using flavor, juiciness, fatty flavor and hardness descriptors, to determine differences on cooked meat. PCA was performed using PRINCOMP procedure. SP and MCT data was evaluated using GLM procedure from SAS® in a complete random design.

III. RESULTS AND DISCUSION

Results from PCA in raw meat showed positive correlations among yellow and pale color (0.88; *P*=0.02), negative correlations among yellow and red colors (-0.96; *P*=0.0026), pale and red (-0.88; *P*=0.02) and aqueous and consistent texture (-0.86; *P*=0.03). Three first principal components (Prin) auto values explained 83.8% of the original variability; sufficient to explain the sensory effects of feeding pigs with FAP and ENZ. Eigenvectors analysis showed that Prin 1 was defined positively with red color, rancid odor and negatively with yellow and pale color. Prin 2 was positively defined by meat and fresh odors, slightly by pink color and negatively by sticky texture.

Graphical projection of treatments (Figure 1) showed that meat from *T0-0* was defined as pink and slightly red, poor meat odor and, fresh. From *T0-0.1* meat was defined as slightly pink and red and very meat and fresh odors. For *T5-0* treatment meat was defined as poor red and pink, low meat odor and moderately fresh. In meat from *T5-0.1* meat was defined as slightly red and pink although showed less meat and low fresh odor. That was indicator that meat from pigs fed with 5% of FAP and without ENZ obtained low values of red, pink, meat odor and freshness. Meat from treatment *T10-0* was defined as the most red and pink, slight meat and fresh odors and from *T10-0.1* meat was defined as slightly low red and pink but showed the best meat and fresh odors. It can be observed that the best red and pink color, and meat and fresh odor were in meat from pigs fed with 10% of FAP and ENZ. While 5% of FAP addition granted meat less red and pink and showed a low meat and fresh odors.

SP in raw meat showed that meat from different treatments was similar in almost all the evaluated attributes (Figure 2).

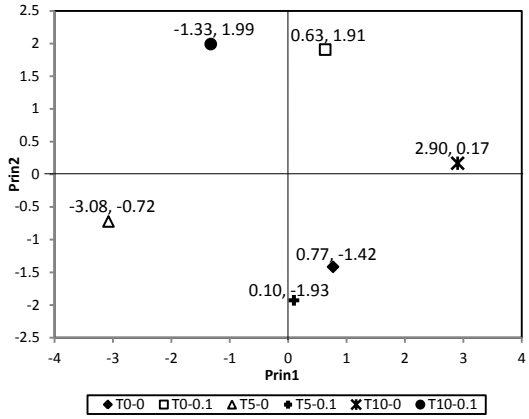

Figure 1. Correlation values considering Prin 1 and Prin 2 of sensory preference values for raw meat of pork. 0-0, 0-0.1, 5-0, 5-0.1, 10-0, 10-0.1 = Treatments. Values in left correspond to Prin1, related with red, yellow, pale and, rancid. Values in right correspond to Prin 2, related with pink color, meat odor, fresh and sticky.

Only treatment *T5-0*, showed variation being qualified as more pale, yellow, less red and little aqueous. In general, meat from pigs fed with FAP and ENZ showed a similar pattern. Meat from pigs fed with 5% of FAP and ENZ showed similar characteristics to meat from pigs fed conventionally, while 10% of FAP addition in pig diet granted a less soft and more consistent meat. When ENZ was added, a little consistent and very aqueous meat could be obtained, which could show a loss of appearance at sale point.

Raw meat from pigs fed with 5 or 10% of FAP maintained similar characteristics with some color, odor and texture differences what demonstrated that it was possible to obtain meat with more intense red and pink color when 5 and 10% of FAP was added. More intense meat and fresh odors were obtained when 10% of FAP was added and, higher consistency with 10% of FAP without ENZ. Indeed these effects could be caused by feeding [15]. It was showed that with 10% of FAP and ENZ addition, meat decreased moisture and increases their intramuscular fat content [16], which should give more tenderness. However, when meat is more aqueous, it presents more toughness, although the relation among this characteristics and hardness is still not totally clarified [17]. Rødbotten *et al*. [8] mention that sensory changes in meat could be dependent on the diet

type. This authors specified that animals that were fed with more natural or not conventional feeds, could give more flavor and odor intensity. This is due to some molecules which may infiltrate these characteristics.

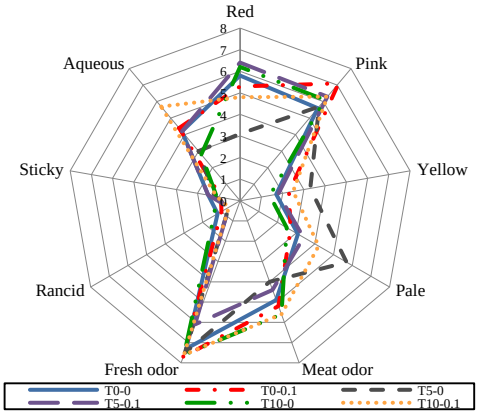

Figure 2. Least square means from raw meat descriptors

In this sense, it could be observed in PCA analysis that red and yellow color and pale relation was negative, which means that meat from treatments with 10% of FAP was qualified as redder, more pink and low odor, however when ENZ was added, the red and pink intensity decreased but odor increased. Thus, it could be considered that meat from pigs without addition of FAP was qualified with low color and odor. Nonetheless when FAP and ENZ were added in the diets these characteristics increased which could make this meat more attractive at sale point. As mentioned by Troy and Kerry [3], these are two of the most striking characteristics in consumers purchase decision. In cooked meat (Table 1) there were no differences in flavor, fatty and hardness (P>0.05) while juiciness was affected (P<0.05) being meat from pigs fed with 5 and 10% of FAP with or without ENZ juicier.

Table 1. Least square means from descriptors for cooked meat

Item	Treatments (%FAP-%ENZ)						
	0-0	0-.1	5-0	5-.1	10-0	10-.1	*SEM*
Flav	5.0	5.1	5.3	5.3	4.6	5.2	0.46
Juic	5.0^{b}	5.9^{a}	6.5^{a}	6.7^{a}	5.5^{ab}	6.5^{a}	0.47
Fat	5.0	5.3	5.1	5.8	4.7	5.4	0.28
Ha	5.0	4.5	4.8	4.1	5.2	4.6	0.48

Literals a, b, among columns, means difference at *P*<0.05. Flav=flavor, Juic=juiciness, Fat=fatty, Ha=hardness; SEM=Standard error of the mean.

It is possible that juiciness increase was related to the increase of intramuscular fat content in the LDM [18]. Nevertheless, it have been reported that there is a relation between red color increase and juiciness [19] which could explain the fact that meat from pigs fed with 10% of FAP with increased red color, showed a juiciness increased.

Results obtained in this sensory evaluation agree with Lee *et al*. [12] who refer to an increase in juiciness and tenderness in meat from pigs feed with apple pomace. Indeed, they reported an increase in flavor while in this experiment flavor did not show any increase (P>0.05). Kim *et al*. [14] mentioned that in an experiment with fruit by-product, the juiciness, tenderness and flavor were increased, showing that by-products improved sensory characteristics. On the contrary, in other experiments with fermented vegetal by-products, Lee *et al*. [13] did not reported significant effects (P>0.05) in flavor, odor and juiciness. In the same way Newman *et al*. [11] did not mention significant effects in juiciness and flavor although a decrease in tenderness for feeding pigs with agricultural by-products was observed, indicating that this decrease was not expected, because it was reported a tenderness effect in beef. Johanson *et al*. [20] did not reported differences in texture attributes when Hampshire pigs were fed with a fermented by-product, arguing that effects on meat quality are variable and dependent of ageing time. However in the literature review of this work, it was not found any information about the effects of apple by-products in sensory quality; except on Lee *et al*. [12] experiment. Effects of feeding by-products are dependent on their type and origin and could be positives or negatives. The tendency showed that vegetal by-products affects negatively, while fermented pulp fruit by-products produce improvement on sensory characteristics as in this experiment.

IV. CONCLUSIONS

Meat from pigs fed with 5% of FAP and ENZ has similar sensory characteristics to meat from pigs fed conventionally. Meat from pigs fed with 10% of FAP might have better appearance than meat from pigs fed conventionally, at sale point.

The addition of ENZ in the diet of pigs will produce meat with less attractive appearance at sale point. Addition of 5 or 10% of FAP with ENZ improves juiciness on cooked meat.

REFERENCES

1. Aaslyng, M. D., M. Oksama, E. V. Olsen, C. Bejerholm, M. Baltzer, G. Andersen, W. L. P. Bredie, D. V. Byrne and G. Gabrielsen. 2007. The impact of sensory quality of pork on consumer preference. Meat Sci. 76: 61 – 73.
2. Dickinson, D. L. and D. V. Bailey. 2005. Experimental evidence on willingness to pay for red meat traceability in the United States, Canada, The United Kingdom and Japan. Journal of Agricultural and Applied Economics. 37(3): 537 – 542.
3. Troy, D. J. and J. P. Kerry. 2010. Consumer perception and the role of science in the meat industry. Meat Sci. 86: 214 – 226.
4. Jonsäll, A. 2000. Sensory quality of pork. Influences of rearing system, feed, genotype and sex. Dissertation for the Degree of Doctor of Philosophy in Domestic Sciences. Uppsala University. Sweden.
5. Dransfield, E., T. M. Nagpo, A. N. Nielson, L. Bredahl, P.O. Sjödén, M. Magnusson, M. M. Campo and G. R. Nute. 2005. Consumer choice and suggested price for pork as influenced by its appearance, taste, and information concerning country of origin and organic pig production. Meat Sci. 69: 61 – 70.
6. Miller, R. 1998. Sensory evaluation of pork. National Pork Board. 04526- 5(1): 1–20. http://www.pork.org/filelibrary/Factsheets/PorkScience/q-sensoryeval04526.pdf. 10 Jun, 2011.
7. Verbeke, W., M. J. Van Oeckel, N. Warnants, J. Viaene and Ch. V. Boucqué. 1999. Consumer perception, facts, and possibilities to improve acceptability of health and sensory characteristics of pork. Meat Sci. 53: 77 – 99.
8. Rødbotten, M., E. Kubberød, E. Lea and Ø. Ueland. 2004. A sensory map of the meat universe, Sensory profile of meat from 15 species. Meat Sci. 68: 137 – 144.
9. Bryhni, E. A., D. V. Byrne, M. Rødbotten, S. Mømoller, C. Claudi-Magnussen, A. Karlsson, H. Agerhem. M. Johansson and M. Martens. 2003. Consumer and sensory investigations in relation to physical/chemical of cooked pork in Scandinavia. Meat Sci. 65: 737 – 748.
10. Sánchez, I. and W. Albarracín. 2010. Análisis sensorial en carne. Rev. Col. Cienc. Pec. 23: 227 – 239.
11. Newman, D. J., E. K. Harris, E. P. Berg and H. H. Stein. 2011. Effects of pea chips on pig performance, carcass quality and composition, and palatability of pork. J. Anim. Sci. Published online. April 21, 2011. DOI: 10.2527 jas.2010 – 3000.
12. Lee, S. D., H. Y. Kim, H. J. Jung, S. Y. Ji, R. Chowdappa, J. H. Ha, Y. M. Song, J. C. Park, H. K. Moon and C. Kim. 2009a. The effect of fermented apple diet supplementation on the growth performance and meat quality in finishing pigs. Anim. Sci. J. 80: 79 – 84.
13. Lee, S. D., H. Y. Kim, Y. M. Song, H. J.Jung, S. J. Ji, H. D. Jang, J. W. Ryu, J. C. Park. H. K. Moon and C. Kim. 2009b. The effect of Eucommia ulmoides leaf supplementations on the growth performance, blood and meat quality parameters in growing and finishing pigs. Anim. Sci. J. 80: 41 – 45.
14. Kim, H. Y., Y. M. Song, S. K. Jin, J. S. Kim, Y. S Kang, S. D. Lee, R. Chowdappa, J. H. and S. M. Kang. 2006b. The effect of change in meat quality parameters on pig Longisimus dorsi muscle by the addition of fermented persimmon shell diet. Asian-Aust. J. Anim. Sci. 19: 286 – 291.
15. Pettigrew, J. E. and M. A. Esnaola. 2001. Swine nutrition and pork quality: A review. J. Anim. Sci. 79 (E. Suppl.): E316 – E342.
16. Chamorro-Ramírez, F. H., J. A. García-Macías, E. M. Peña-González, L. A. Durán-Meléndez and O. García-Rodríguez. 2011. Evaluation of a solid-state fermented Apple byproduct feed on nutrient content and quality of pork meat. Abstracts from the 64th Reciprocal Meat Conference of the American Meat Science Association. Meat Science, 98: 325 – 371.
17. Dilger, A. C., P. J. Princker, J. M Eggert, F. K. McKeith and J. Killefer. 2010. Pork tenderness and postmortem tenderization: Correlations with meat quality traits and the impact on sire line. J. Muscle Foods. 21: 529 – 544.
18. Fortin, A., W. M. Robertson and A. K. W. Tong. 2005. The eating quality of Canadian pork and its relationship with intramuscular fat. Meat Sci. 69: 297 – 305.
19. Norman, J. L., E. P. Berg, H. Heymann and C. L. Lorenzen. 2003. Pork loin color relative to sensory and instrumental tenderness and consumer acceptance. Meat Sci. 65: 927 – 923.
20. Johanson, L., K. Lundström, A. Jonsäll and T. Lundh. Effects of red clover silage and ageing time on sensory characteristics and cooking losses of loin (M. Longissimus dorsi) from Hampshire crosses with and without the RN-allele. Food Qual. Pref.. 10: 299 – 303.