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INFLUENCE OF CASSAVA LEAF (*MANIHOT ESCULENTA* CRANTZ) MEAL SUPPLEMENTATION ON THE NUTRITIVE VALUE OF CAVY (*CAVIA PORCELLUS*) MEATFonteh A Florence^{1*}, Mweugang N Nathalie¹, Tendonkeng Fernand and Pamo T Etienne¹

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The study investigates the use of Cassava Leaf Meal (CLM) as a cheaper alternative protein source to replace soybean cake in the diet of cavy. The effect of this replacement on the chemical composition of cavy meat was evaluated. Forty-eight guinea pigs (24 females and 24 males) were distributed in a completely randomized experimental design. The animals were divided into 4 groups and given *Pennisetum purpureum* ad libitum supplemented with one of the experimental diets: RC0, RC8, RC10 and RC12 containing respectively 0, 8, 10 and 12 % of CLM. After 22 weeks, meat from the breast, thigh and shoulder, were analyzed. Results revealed that, water and ash contents in all the meat types were similar ($P > 0.05$) irrespective of sex and diet. Incorporating 8% and 12% CLM led to a significant increase ($P < 0.05$) in protein levels in the breast (22.89%) and shoulder (22.43%) of females and in the thigh (21.68%) and shoulder (21.09%) of males. The lipid contents of female thighs (10.52%) and shoulders (15.95%) from diet RC12 were greater than for males (5.26 and 8.82%) given the same diet. CLM can satisfactorily replace soybean cake for growing cavy as a non-conventional source of highly nutritive animal protein.

Keywords: *Pennisetum purpureum*, Soybean cake, Cassava leaf meal, Chemical composition, Cavy meat

INTRODUCTION

The rearing of non-conventional animal species is considered as the fastest and most effective strategy for reducing the deficit of animal proteins in the diets of people in developing countries (Defang *et al.*, 2014; and Kenfack *et al.*, 2015). The major role played by these species in income generation, food supply and financial security for rural populations has been demonstrated (Ngou Ngoupayou *et al.*, 1995; and Niba *et al.*, 2012). In this light, cavy husbandry seems an ideal option towards reducing animal protein deficiency in poor Cameroonian households (Ngou Ngoupayou *et al.*, 1995).

Cavy (*Cavia porcellus*, Linnaeus, 1758) is a domestic

rodent which is very prolific, rustic and with a high productivity rate (kg of meat produced per female per year) of 64.9% compared to 35% rate for sheep (Combes, 2004). In developing countries, they feed mainly on locally available forage and kitchen residues (Niba *et al.*, 2012). Previous research work has shown that supplementing the diet with concentrates (soybean and cotton seed cakes, etc.) significantly improves the production performance of cavy (Fotso *et al.*, 1995; and Ngou Ngoupayou *et al.*, 1995). However, soybean cake is expensive for poor households (Niba *et al.*, 2012). Therefore alternative cheaper protein sources need to be identified for incorporation in cavy diets. Cassava leaf seems promising because it is relatively high in protein, cheap and easily available (Dada and Oworu, 2010).

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Irrespective of the animal species, certain factors influence the nutritive properties of the meat including the sex and feeding regime (Combes, 2004). The nutritive quality of cavy meat as influenced by these factors has not yet been evaluated in Cameroon, as is the case with other types of meat. This study therefore seeks to evaluate the effect of replacing soybean cake in cavy diet with cassava leaf meal on the nutritive value of cavy meat.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Research farm, the Food science/nutrition and the Soil science laboratories of the University of Dschang. Dschang is found in the Western region of Cameroon (Central Africa) and located at longitude 10°26' East and latitude 5°26' north of the Equator.

Animals and Housing

Forty eight adult guinea pigs (cavies) comprising 24 males and 24 females were used for the study. All were 22 weeks old with an average weight of 522.21±28.88 g (for the females) and 566.75±43.13 g (for the males). The animals were raised in pens at the research farm. The floor of the pens was covered with saw dust which was replaced every two days. Throughout the study period, each pen was heated by an electric bulb.

Feeding Rations and Experimental Design

Four rations: RC0, RC8, RC10 and RC12 (Table 1) were formulated by gradually increasing the proportion of cassava leaf meal (CLM) (0, 8, 10 and 12%) in replacement of soybean cake in the control ration. The feeding rations were established based on cavy's nutrient requirements as recommended by Numbela and Valencia (2003). CLM was obtained by harvesting leaves from cassava plants growing at the Dschang University farm. The leaves were sun dried, ground and stored in plastic bags until used. Each of the 4 rations was assigned randomly to 4 groups of animals. The animals were distributed in a completely randomized block design with 12 replicates per ration, six of which were per sex and per group. The weight of the corresponding experimental ration provided to each group was recorded, water and *Pennisetumpurpureum* were served *ad libitum*. Feed was administered once daily (between 6 and 8 am). The water provided contained vitamin C and was replaced every morning.

Data Collection

Preparation of the Meat Samples

After 22 weeks of feeding, 12 animals (6 males and 6 females) per ration were deprived of feed for 12 hours. They were killed by puncturing of the jugular vein. After bleeding was complete, the carcasses were eviscerated and dressed. Meat (150 g) was collected from the thighs, breasts and shoulders respectively and used for chemical analysis.

Chemical analysis

Dry Matter (DM), crude ash, crude fat (lipid) and crude protein contents were obtained as described (AOAC, 1990). Moisture content was obtained using the formula: % Moisture = 100-DM.

Statistical Analysis

Analysis of variance (ANOVA) was done using the General Linear Model approach (SPSS version 19.0). Means were separated for significant differences ($p < 0.05$) using Duncan's multiple range test (Steel and Torrie, 1980).

RESULTS

Moisture Content

The moisture contents of the different cavy meat types in relation to sex and feeding ration are presented in Table 2. Irrespective of the feeding ration and meat type, the moisture content varied from 60.38 to 75.39%. With respect to sex, the moisture content in female breast given ration RC12 (65.56%) was significantly lower ($P < 0.05$) than for males given the same ration (71.97%). Still for the breast, the moisture content was statistically similar ($P > 0.05$) in all the other rations compared to that in the control, irrespective of sex. Irrespective of feeding ration or sex, the moisture content in the thigh did not vary significantly ($P > 0.05$). However, the moisture contents of the shoulder meat from rations RC0, RC8 and RC12 were significantly higher ($P < 0.05$) in males than in females.

Protein Content

The protein content in the different meat types varied from 13.64 to 21.68% in male carcasses and from 13.58 to 22.89% in females (Table 3). The protein contents in the breast of males in the supplemented rations were respectively similar ($P > 0.05$) to that in the control ration. However, the protein content in the breast of females was significantly higher ($P < 0.05$) in ration RC8 (22.89%) than in the other rations. The protein content in male thigh was significantly higher

Table 1: Composition of Experimental Rations and of *P. purpureum*

Ingredients	Rations				
	RC0	RC8	RC10	RC12	<i>P. purpureum</i>
Maize	31	44	45	45	
Wheat bran	48	31	30	28	
Soyabean cake	6	4	2	0	
Cottonseed cake	2	1	1	2	
Palm kernel cake	4	1	1	1	
Fish flour	5	7	7	8	
Bone flour	2	2	2	2	
Iodised salt	1	1	1	1	
Premix* 0.5%	1	1	1	1	
CLM	0	8	10	12	
Total	100	100	100	100	
Chemical Composition					
Dry matter (%)	90.85	90.38	91.5	90.61	90.3
Organique matter (% DM)	89.52	86.95	87.69	86.46	86.32
Crude proteines (% DM)	19	18.75	18.81	17.18	7.89
Crude fat (% DM)	4.66	4.27	6.19	6.13	2.2
Crude fiber (% DM)	7.74	8.51	9.71	10.69	33.46
Ash (% DM)	10.48	13.05	12.31	13.54	9.68
ME (Kcal/KgDM)	2915.65	2896	2837.29	3045.51	407.18
Note: * Premix 0.5% flesh: Vit. A = 3000000 UI/kg, Vit. D3 = 600000 UI/kg, Vit. E = 4000 mg/kg, Vit. K3 = 500 mg/kg, Vit. B1 = 200 mg/kg, Vit. B2 = 1000 mg/kg, Vit. B3 = 2400 mg/kg, Biotin = 10 mg/kg, Vit. PP = 7000 mg/kg, Folic acid = 200 mg/kg, Choline chloride=10000mg/kg, Iron sulfate = 8000 mg/kg, Copper (II) sulfate = 2000 mg/kg, manganese oxide = 1400 mg/kg, Calcium iodate = 200 mg/kg, Cobalt carbonate = 200 mg/kg, Sodium selenite = 20 mg/kg, Methionine = 20000 mg/kg, Lysine = 78000 mg/kg, ME: Metabolizable energy; CLM: Cassava Leaf meal.					

($P < 0.05$) in ration RC12 (21.68%) compared to the other rations; but no significant differences between rations were observed in female thighs ($P > 0.05$). For the male shoulder, the protein content in ration RC12 (21.09%) was significantly higher ($P < 0.05$) than in the other rations. Furthermore, protein was significantly lower ($P > 0.05$) in rations RC8 (13.91%) and RC10 (13.64%) compared to the control ration (18.60%). The protein in female shoulder from rations RC10 (16.55%) and RC12 (13.58%) were similar ($P > 0.05$) to that of the control ration RC0 (15.29%), while that of ration RC8 (22.43%) was significantly ($P < 0.05$) higher in

comparison to the other rations. With respect to sex, the protein contents in RC8 and RC10 was higher in females than males, irrespective of the meat type.

Lipid Content

The lipid contents from different meat types varied between 5.26 and 12.73% in males and between 6.24 and 15.95% in females (Table 4). The lipid content in the breast showed no significant difference ($P > 0.05$) between males and females irrespective of the ration given. No significant differences were observed in female thigh and shoulder irrespective of the ration given. However, the lipid contents in male thigh

Table 2: Moisture Content (%) of Various Cavy Meat Types with Respect to Inclusion Level of Cassava Leaf Meal

Rations						
	Meat Type		RC0	RC8	RC10	RC12
Moisture Content (%)	Breast		73.2 ± 0.72 ^a _A	73.62 ± 1.09 ^a _A	73.54 ± 1.75 ^a _A	71.97 ± 1.09 ^a _A
			68.65 ± 1.87 ^a _A	70.37 ± 0.80 ^a _A	71.64 ± 2.07 ^a _A	65.56 ± 2.66 ^a _B
	Thigh		73.56 ± 0.95 ^a _A	75.39 ± 1.65 ^a _A	74.56 ± 0.23 ^a _A	73.16 ± 1.39 ^a _A
			71.05 ± 1.55 ^a _A	73.23 ± 0.48 ^a _A	69.01 ± 2.19 ^a _A	69.19 ± 2.09 ^a _A
	Shoulder		72.95 ± 0.03 ^a _A	74.86 ± 1.36 ^a _A	70.45 ± 0.24 ^a _A	70.54 ± 0.53 ^a _A
			66.58 ± 1.05 ^a _B	70.99 ± 1.26 ^a _B	70.40 ± 1.29 ^a _A	60.38 ± 2.29 ^a _B

Note: ^{a, b} Means in the same row with a common letter are not significantly different (P>0.05). _{A, B}: Means in the same column with a common letter are not significantly different (P>0.05).

Table 3: Protein Content (% Fresh Matter) of Various Cavy Meat Types with Respect to Inclusion Level of Cassava Leaf Meal

Rations						
	Meat Type		RC0	RC8	RC10	RC12
Protein Content (%)	Breast		20.28 ± 0.72 ^a _A	19.44 ± 0.55 ^a _A	20.23 ± 1.01 ^a _A	20.51 ± 1.50 ^a _A
			17.20 ± 0.99 ^a _A	22.89 ± 0.67 ^b _A	22.74 ± 0.37 ^c _A	16.19 ± 1.35 ^a _B
	Thigh		18.74 ± 0.89 ^a _A	17.68 ± 0.93 ^a _A	15.34 ± 0.09 ^b _A	21.68 ± 1.10 ^c _A
			18.04 ± 1.43 ^a _A	20.09 ± 0.14 ^a _B	18.11 ± 0.51 ^a _B	17.17 ± 0.66 ^a _B
	Shoulder		18.60 ± 0.41 ^a _A	13.91 ± 0.93 ^b _A	13.64 ± 0.23 ^c _A	21.09 ± 0.60 ^d _A
			15.29 ± 0.71 ^a _B	22.43 ± 1.31 ^b _B	16.55 ± 0.48 ^a _B	13.58 ± 0.79 ^a _B

Note: ^{a, b} Means in the same row with a common letter are not significantly different (P>0.05). _{A, B}: Means in the same column with a common letter are not significantly different (P>0.05).

Table 4: Lipid Content (% Fresh Matter) of Various Cavy Meat Types with Respect to Inclusion Level of Cassava Leaf Meal

Rations						
	Meat Type		RC0	RC8	RC10	RC12
Lipid Content (%)	Breast		6.83 ± 0.10 ^a _A	7.78 ± 1.28 ^a _A	7.25 ± 0.39 ^a _A	6.13 ± 0.04 ^a _A
			7.70 ± 1.13 ^a _A	6.45 ± 2.24 ^a _A	6.46 ± 1.67 ^a _A	8.90 ± 0.04 ^a _A
	Thigh		7.30 ± 0.33 ^a _A	8.94 ± 0.24 ^b _A	8.45 ± 0.67 ^a _A	5.26 ± 0.28 ^c _A
			9.04 ± 1.00 ^a _A	6.24 ± 0.05 ^a _A	7.85 ± 1.86 ^a _A	10.52 ± 0.61 ^a _B
	Shoulder		10.15 ± 0.45 ^a _A	12.73 ± 0.31 ^b _A	12.30 ± 0.50 ^c _A	8.82 ± 0.30 ^d _A
			13.77 ± 0.55 ^a _B	10.47 ± 0.77 ^a _A	13.50 ± 1.92 ^a _A	15.95 ± 0.99 ^a _B

Note: ^{a, b} Means in the same row with a common letter are not significantly different (P>0.05). _{A, B}: Means in the same column with a common letter are not significantly different (P>0.05).

Table 5: Ash Content (% DM) of Various Cavy Meat Types with Respect to Inclusion Level of Cassava Leaf Meal

Rations					
	Meat Type	RC0	RC8	RC10	RC12
Ash Content (%)	Breast	5.17 ± 0.94 ^a _A	4.11 ± 0.93 ^a _A	5.43 ± 0.74 ^a _A	4.63 ± 0.38 ^a _A
		5.00 ± 0.42 ^a _A	3.90 ± 1.27 ^a _A	5.03 ± 0.25 ^a _A	4.93 ± 0.26 ^a _A
	Thigh	5.64 ± 0.69 ^a _A	4.27 ± 0.03 ^a _A	5.33 ± 0.49 ^a _A	4.34 ± 0.62 ^a _A
		5.79 ± 0.30 ^a _A	5.77 ± 0.19 ^a _A	5.50 ± 0.71 ^a _A	5.30 ± 0.42 ^a _A
	Shoulder	5.50 ± 1.34 ^a _A	4.56 ± 1.49 ^a _A	5.43 ± 0.68 ^a _A	5.70 ± 0.63 ^a _A
		5.11 ± 0.28 ^a _A	4.85 ± 0.35 ^a _A	4.99 ± 0.01 ^a _A	4.32 ± 1.87 ^a _A

Note: ^{a, b} Means in the same row with a common letter are not significantly different (P>0.05). _{A, B}: Means in the same column with a common letter are not significantly different (P>0.05).

from rations RC8 (8.94%) and RC12 (5.26%) were significantly different (P<0.05) from those of RC0 (7.30%) and RC10 (8.45%). For male shoulder, the lipid content was significantly higher (P<0.05) in ration RC8 (12.73%) and RC10 (12.30%) than in the other two rations. With respect to sex, the lipid contents of female shoulder from rations RC12, RC0 and female thigh from ration RC12 were significantly higher (P<0.05) than for males.

Ash Content

Irrespective of the ration given, sex and meat type analyzed, the ash contents of the animals in the rations receiving cassava leaf meal were not significantly different (P>0.05) from those given the control ration RC0 (Table 5). Nevertheless, the ash content was highest in the thigh of females receiving the control ration RC0 (5.79%) and lowest in breast of females receiving ration RC8 (3.90%).

DISCUSSION

Irrespective of meat type or sex, the incorporation of CLM did not seem to significantly affect the moisture content (P>0.05). These results are similar to that reported by Horcada *et al.* (1998) who reported no sex influence on the moisture content of meat from the *Longissimusdorsi* of Spanish lambs. The high moisture content in cavy meat recorded in this study varied between 60 and 75%, which is similar to that of rabbit (66%) and that of chicken (75%) as reported by Nout *et al.* (2003) and Combes (2004). It was also similar to that of beef (72-75%) as reported by Fonteh *et al.* (2015) and that of pork (55-75%) as reported by Cheftel *et al.* (1985). However, cavy meat is lower in moisture content

than meat from wild cane rat (77.35%) (Nteme Ella *et al.*, 2014).

The incorporation of 12% cassava leaf meal (RC12) in cavy diet seemed to have improved protein content of meat from male cavies especially at the thigh and shoulder regions. These meat types showed sex differences in protein content. These results are contrary to those of Pugliese *et al.* (2004) and Nteme Ella *et al.* (2014) who reported that sex did not influence the protein content of pork of cane rats respectively. Compared to meat from other animal species, the average protein content of cavy meat (18.24%) is similar to that of pork (18.2%) as reported by Rinaldo and Mourot (2002) and that of rabbit (19.5-22.5%) as reported by Combes (2004). However, cavy meat is lower in protein content in comparison to chicken which varies between 20 and 20.5% (Nout *et al.* 2003) and beef which varies between 22 and 25% (Fonteh *et al.*, 2015).

Overall, the lipid content was higher in all meat types from females given rations RC0 and RC12 compared to males given the same ration. Sex influence observed in this study agrees with the results of Horcada *et al.* (1998) who, using the *Longissimusdorsi* muscle of lambs reported that the fat content was higher in females (2.74-3.54%) than in males (1.87-3.15%) but is contrary to Nteme Ella *et al.* (2014) who reported no such influence. Our results also corroborate those of Combes (2004) who reported that lipid content varies with the anatomical part of the animal. Our results show that cavy meat has an average lipid content of 10.61% which is higher than reported for veal (1-7%), chicken (0.9 to 12%), bullock (3 to 14%) as reported by Dalle (2004) as

well as that of cane rat (1.4-1.47%) as reported by Nteme Ella *et al.* (2014). It is however lower than that of pork (3 to 22%) as reported by Dalle (2004). Cavy meat is considered as to be fatty because its lipid content is greater than 6% (Mirand and Remond, 2008).

Irrespective of feeding regime or sex, the ash content in the different meat types were similar ($p < 0.05$), implying that the introduction of cassava leaf meal did not influence ash content. The values obtained in our study varied between 3.90 and 5.79%, indicating that cavy muscle is a good source of minerals. The values obtained are similar to that reported by Olusola *et al.* (2012) for beef (4.42%) but higher than that of cane rat (1.2%) as reported by Nteme Ella *et al.* (2014).

CONCLUSION

The results of this study have shown that the incorporation of cassava leaf meal in cavy diet led to the production of good quality cavy meat whose protein content is similar to that of rabbit and pork. Furthermore, chemical analysis revealed that the nutrient content varies with the part of the animal as well as with the sex of the animal. The meat parts studied (breast, thigh, shoulder) were rich in protein, moisture and ash contents. Protein was highest in the breast (22.89%) of females receiving ration RC8, lipid was highest in the shoulder (15.95%) of females receiving ration RC12 and ash was highest in the thigh (5.79%) of females receiving the control diet RC0. Therefore cassava leaf meal can satisfactorily replace soyabean meal in growing cavies as a non-conventional source of animal protein.

REFERENCES

- AOAC (Official Methods of Analysis) (1990), *Association of Official Analytical Chemists*, Edition, p. 684, Washington DC.
- Cheftel J C, Cuq J L and et Lorient D (1985), *Protéines alimentaires*, Editions Technique et Documentation/Lavoisier, p. 320, Paris, France.
- Combes S (2004), *Valeur nutritionnelle de la viande de lapin*, *INRA Prod. Anim.*, Vol. 17, No. 5, pp. 373-383.
- Dada A O and Oworu O O (2010), "Mineral and Nutrient Leaf Composition of Two Cassava (*Manihotesculenta* Crantz) Cultivars Defoliated at Varying Phenological Phases", *Not Sci. Biol.*, Vol. 2, No. 4, pp. 44-48.
- Dalle Z A (2004), *Le lapin doit apprivoiser le consommateur: avantages diététiques*, *Viandes Produits Carnés*, Vol. 23, pp. 161-167.
- Defang H F, Keambou T C, Manjeli Y, Tegua A and et Pamo T E (2014), *Influence de la farine des feuilles de Leucaenaleucocephalus sur les performances de croissance des lapereaux*, *Int. J. Biol. Chem. Sci.*, Vol. 8, No. 4, pp. 1430-1437.
- Fonteh F A, Bawe N M, Tuncha N P, Bessong O W, Muluh M E and Piasentier E (2015), "Influence of Production System on the Quality of Gudali Beef in Cameroon", *Livestock Research for Rural Development*, Vol. 27, p. 29, available from <http://www.lrrd.org/lrrd27/2/font27029.htm>
- Fotso J M, Ngoupayou N J D and et Kouonmenioc J (1995), *Performances expérimentales des cobayes élevés pour la viande au Cameroun*, *Note de recherche Institut de Recherches Zootechniques et Vétérinaires (IRZV), Cahiers Agricultures*, Vol. 4, pp. 65-69.
- Horcada A, Beriain M J, Purroy A, Lizaso G and Chasco J (1998), "Effect of Sex on Meat Quality of Spanish Lamb Breeds (*Lacha* and *Rasa Aragonesa*)", *Journal of Animal Sciences*, Vol. 67, pp. 541-547.
- Kenfack A, Narcisse Vemo B, Ngoula F, Fonteh Anyangwe F, Kegne Chombong J, Martine Magnimeza Tsambou A and et Tchoumboué J (2015), *Caractéristiques de la production laitière chez la lapine locale camerounaise (*Oryctolagus cuniculus*)*, *Livestock Research for Rural Development*, Vol. 27, p. 121, available from <http://www.lrrd.org/lrrd27/7/kenf27121.html>
- Mirand P P and et Rémond D (2008), *La viande, un aliment vanté ou décrié: un point sur ses propriétés nutritionnelles et sa place dans une alimentation humaine équilibrée*, *Inra et CRNH Auvergne, Unité de Nutrition Humaine, Clermont-Ferrand*, France, CRA-W&FUSAGx- Carrefour, Productions Animales.
- Ngou Ngoupayou J D, Kouonmenioc J, Fotso Tagny J M, Cicogna M, Castroville C, Rigoni M and Hardouin J (1995), *Possibilités de développement de l'élevage du cobaye en Afrique subsaharienne: le cas du Cameroun*, *World Animal Review*, FAO/AGA, Vol. 83, No. 2, pp. 20-28.
- Niba A T, Meutchieye F, Fon D, Laisin A G, Taboh H, Njakoi H, Bela Tomo A, Maass B L, Djikeng A and Manjeli Y (2013), "Current Situation of Cavy Production

- in Cameroon: Challenges and Opportunities”, *Livestock Research for Rural Development*, Vol. 24, p. 194, available from <http://www.lrrd.org/lrrd24/11/niba24194.htm>
- Nout R, Hounhouigan J D and Van Boekel T (2003), *Les Aliments: Transformation, Conservation et Qualité*, p. 268, Backuys Publishers, Leiden, The Netherlands.
 - Nteme Ella G S, Aoussi S, Kouame P, Fantodji A and et Bakou S (2014), *Détermination de la couleur et de la*, *Int. J. Biol. Chem. Sci.*, Vol. 8, No. 2, pp. 610-620.
 - Numbela E R and Valencia C R (2003), “Guinea Pig Management Manual”, p. 54, Benson Agriculture and Food Institute, Provo.
 - Olusola O O, Okubanjo A O and Omojola A B (2012), “Nutritive and Organoleptic Characteristics of Kilishi as Affected by Meat Type and Ingredient Formulation”, *Journal of Animal Production Advances*, Vol. 2, No. 5, pp. 221-232.
 - Pugliese C, Calagna G, Chiofalo V, Moretti V M, Margiotta S, Franci O and Gandini G (2004), “Comparison of the Performances of Nerosiciliano Pigs Reared Indoors and Outdoors: 2, Joints Composition, Meat and Fat Traits”, *Meat Science*, Vol. 68, pp. 523-528.
 - Rinaldo D and Mourot J (2002), “Effects of Tropical Climate and Season on Growth, Chemical Composition of Muscle and Adipose Tissue and Meat Quality in Pigs”, *Animal Research*, Vol. 50, pp. 507-521.
 - Steele R G and Torrie J H (1980), “Principles and Procedures of Statistics”, p. 633, McGraws Hill Book C, New York.

