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NUTRITIONAL VALUE OF CHINCHILLA MEAT AND ITS AGROINDUSTRIAL DERIVATIVES

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ABSTRACT
The aim of this study is to provide new information increase the knowledge on Chinchilla *(Chinchilla laniger)* meat quality characteristics and compare it with other exotic meats. The chinchilla´s is a rodent raised in confinement for their fur and meat is considered as a byproduct of the process and is currently discarded. In this study we proceed to analyze the chinchilla raw meat by proximate analysis and compared its characteristic to other studies on exotic meats. Chinchilla raw meat was found to have less or similar crude protein, and fat than other rodents meats. Fatty acid profile is interesting because it had around 75% of monounsaturated and polyunsaturated fatty acids. Different agro-industrial preparations were made, analyzed chemically and tested by a sensory panel to obtain their organoleptic characteristics. Finally the meat was tested with a trained and non-trained tasting panel, the panel results indicate that the meat was accepted with good scores.

1. Introduction

The Chinchilla *(Chinchilla laniger)* has been hunted and bred for its light, fine and dense fur, which has a significant value for the trade. Its value has led to an irrational hunting that endangered this specie in the past. Nowadays, in Chile, wild *Chinchilla laniger* is protected by the government (Marinovic, 1990), which led to breeding performed under confinement ecological conditions because of its of major importance for the fur industry (Parker, 1982). Since the main objective in breeding Chinchilla is the fur, the meat is disposed without any use because of the lack of knowledge in its potential use for human consumption (Echalar et al., 1998). The nutritional value of the Chinchilla meat was first studied by Echalar et al., (1998), concluding that the meat has good food value and acceptability, no further studies have been conducted so far over this exotic meat. As Hoffman and Cawthorn (2013) indicates, there will be an increase in non-traditional meats and more research is required on the nutritional composition on the meats from alternate sources.

Chinchilla is native to the high and dry areas of Los Andes Mountains, Chile, Argentina, Perú and Bolivia (Adaro et al., 1999). The chinchilla belongs to the order of Rodentia and the suborder of Hystricognatha (Caviomorpha) (Spotorno et al., 2004 a). Chinchillas and mountain pampas viscachas

(*Lagidium* and *Lagostomus*) are in the C*hinchillidae* family (Spotorno et al., 2004 b). The genus chinchilla has two surviving species: *Ch. brevicaudata* (short tail chinchilla) that lives in the altiplanic area of Los Andes and *Ch. lanigera* (long tail chinchilla) that lives in the northern district of Chile known as Chile Chico.

In the work by Echalar et al., (1998) they determined the nutritional value of Chinchilla meat for three groups: raw, treated with dry heat and treated with wet heat. Also they compared the proximate composition with other meats such as: Vizcacha, cow, pig and chicken. They did not compared the proximal analysis to other rodents, such as Guinea Pig, commonly consumed in South America and did not performed an analysis of the fatty acid composition of the Chinchilla Finally, they analyzed the acceptance of the preparation using a panel of 30 trained judges. In their acceptance analysis they only asked the level of acceptance of the three treatments using a 3 level scale (like, indifferent and dislike).

Our goal is to complement the studies of Echalar et al., (1998) and Antonio et al., (2007) by extending the nutritional value assessment of the meat from chinchillas to the fatty acid composition. We compare its composition with other works published in non-traditional meats, such as: guinea pig (Kouakou et al., 2013), Capybara (Girardi et al., 2005), and Nutria (Cabrera et al., 2007). Finally we present other agro-industrial preparations such as: smoke-baked chinchilla meat, confit in vegetable oil and confit in lard; we present the results of acceptability performed with trained and untrained panel of consumers.

2. Materials and methods

Animals

Chinchillas used in this study were obtained from a commercial nursery located in Pirque (Central area of Chile). We used 66 chinchillas for raw meat analysis and for derivatives (Figure 1). In the case of raw meat analysis, fat and meat of eight animals were separated and analyzed in the laboratory of the Departamento de Ciencias Animales de la Facultad de Agronomía e Ingeniería Forestal de la Pontificia Universidad Católica de Chile.

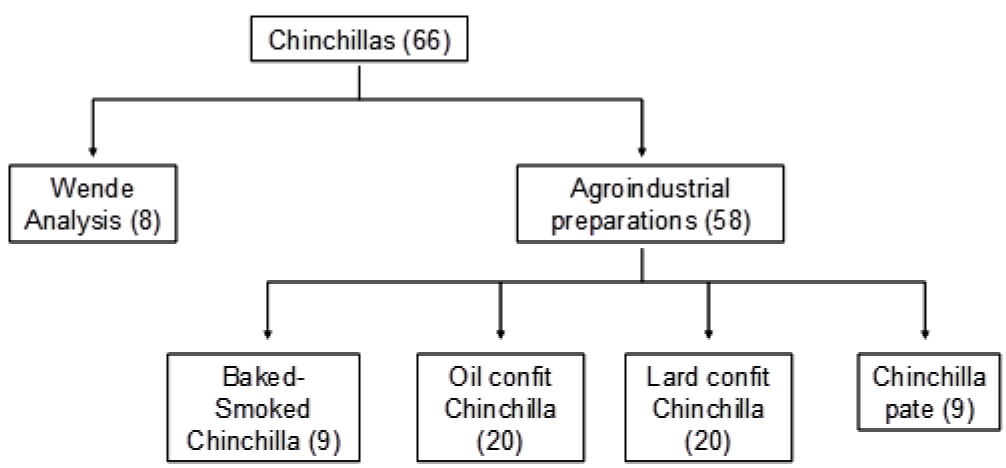

Figure 1. Used chinchillas.

Figure 2. A) Baked chinchilla; B) Oil confit of chinchilla; C) Lard confint of chinchilla

Chemical Analysis

Nutritional value of meat was determined by Weende or Proximate Analysis by obtaining dry matter (drying in a stove for 4 hours at 105 °C), protein (Kjeldahl method), fat (Soxhlet method) and carbohydrates (Crude Fiber and non nitrogen extract) (Methodenbuch 1998).

Fatty acid profile of the interstitial fat was determined by gas chromatography (Firestone, 1989) at Instituto de Nutrición y Tecnología de los Alimentos of Universidad de Chile.

Agroindustrial Preparations

Four different meat agroindustrial preparations of chinchilla were prepared:

Baked-Smoked chinchilla

A total of 9 carcasses (2.5 kg) were marinated in water (98%), ice (17%), Prinaham® (Sodium polyphosphate; sugar; salt; sodium erythorbate; sodium nitrite (1.8%)) (6%) and salt (9%) for 24 hours. After marinated they were sprayed with Pluscolor® (Salt; dextrose; sugar; sodium erythorbate; sodium ascorbate) (2 g/kg) and immersed in liquid smoke and water (1:2) for 30 seconds. Finally, they were baked at 120 ºC for 20 min, until inner meat reached 72 ºC. Then they were cooled at room temperature and refrigerated until evaluation (Figure 2A).

Chinchilla confit

Confit in vegetable oil. Twenty carcasses (5.2 kg) were processed to obtain legs and loins (2.47 kg). The legs and loins were washed, dressed with pepper and salted with 150 g of salt and 15 g/kg of Curaid® (Salt; sodium nitrite (6.0%); sodium nitrate (4.0%) for dry and cure and refrigerated for a period of 24 hours. Then they were taken out of the refrigerator and washed and weighed. In the next step the meat was sprayed with a roaster and confited in vegetable oil for eight minutes at 100-102 ºC, until the meat reached 72 ºC. Finally, the pieces (four legs and two loins) were set in glass jars with a capacity of 400 g and filled with new preheated oil at 100 ºC and the jars were sealed and placed upside down to sterilize the lid, and cooled at room temperature (Figure 2B).

Confit in lard. Twenty carcasses (5.3 kg) were processed to obtain legs and half a loin in one piece (2.9 kg). They were then washed, seasoned with pepper (2 g/kg) and salted with 150 g of salt and 15 g/kg of Curaid® for dry and cure and refrigerated for a period of 24 hours. Then they were taken out of the refrigerator and washed and weighed. In the next step the meat was sprayed with a roaster and confited in pork lard for seven minutes at 100-102 ºC, until the meat reached 70 ºC. Finally, they were set in plastic trays filled with new melted lard covering the pieces and cooled at room temperature until the lard solidified and refrigerated until evaluation (Figure 2C).

Sensory Analysis

Organoleptic quality of the product was analyzed through Scoring Method (15 cm non-structured scale), used by Serra et al., (2004) in a cattle meat quality, using 12 trained judges. The parameters evaluated were: appearance, color, aroma, texture, fattiness, consistency, saltiness, bitterness and flavor. The acceptability was evaluated with the Hedonic

Scale method with a non-structured assessment scale (between 0 – 15) with a 24 person non-trained panel.

Statistical Analysis

The statistical analysis was performed with SAS, based on the structure of probability associated with the randomization process. T student test was used to test the differences of the means.

3. Results and discussions

Table 1 shows nutritional composition of chinchilla meat.

Table 1. Nutritional contents of chinchilla meat (male and female)

	Males	Females	p
Weight (g)	461.8	449.8	0.693
Dry matter (DM)	25.9	26.6	0.748
Ether Extract (%)	6.0	6.1	0.974
Crude Protein (%)	18.7	19.5	0.153
Ash (%)	1.1	1.1	0.997
Fatty acid			
Saturated Fatty Acids			
C12:0	0.079	0.074	0.827
C14:0	2,029	1,171	0.390
C16:0	16,814	16,371	0.812
C18:0	3,203	3,066	0.786
C20:0	0.040	0.060	0.440
Monounsaturated Fatty Acids			
C14:1	0.116	0.142	0.522
C16:1	4,670	5,293	0.528
C18:1	29,201	27,966	0.514
C20:1 n9	0.263	0.266	0.926
Polyunsaturated Fatty Acids			
C18:2 n6	36,058	36,407	0.821
C18:3 n6	0.014	0.071	0.156
C18:3 n3	3,197	3,482	0.594
C20:2 n6	0.244	0.237	0.375
C20:3 n6	0.081	0.111	0.204
C20:3 n3	0.023	0.037	0.397
C20:4 n6	0.115	0.133	0.598
C22:5 n3	0.008	0.033	0.022
C22:6 n3	0.065	0.083	0.282

Chinchilla carcass weight was similar in male and female (p=0.6928), which was similar at Antonio et al., (2007) and a little bit different from that reported by Cabrera et al., (2007) in nutria meat (*Myocastor coypus*), where male carcass was heavier than female carcass when protein level in diet was 16% and was similar when protein level in diet were 19% or 22%.

In this study it was not evaluated protein diet intake, then it is needed more research to know if diet protein level is affecting chinchilla carcass weight. There were no differences in crude protein (CP), crude fiber and ash between male and female. Fatty acid profile of chinchilla meat was similar between male and female, except for docosapentaenoic acid (C22:5 n3) which was 4 times higher in female than male. In human health that is very interesting because docosapentaenoic acid belong to omega three family and plays an important role in brain formation and brain connections.

Two previous studies on Chinchilla meat nutritional value (Antonio et al., 2007; Echalar et al., 1998) have not been consistent in CP and fat content of chinchilla meat. Echalar et al., (1998), found that chinchilla meat had about 20% CP and 11.26% fat, while Antonio et al., (2007) showed that chinchilla meat had 16-18% CP and 20-30% fat. Our results are consistent with the results of (Echalar et al., 1998) with a 19%, but the fat content (6%) was below both previous studies. The differences can be attributed to the feed ingredients and other environmental considerations which might affect the fat content, for example genetic differences, since Echalar et al., (1998) research was performed in Argentina. More research is necessary to understand the differences in the fat content. Both studies did not report the fatty acid profile for chinchilla meat, to better understand the sources of the differences in the fat composition.

Crude protein content in similar rodent meats is between 18-24% (table 2). For the case of chinchilla meat, CP is around 19% and if it is compared with other meats it is slightly lower than the CP content in traditional meats (bovine, chicken, pork), but if it is compared with nontraditional meats (other rodents meats) protein content in chinchilla meat is definitely lower than those meats. Rodents may contribute to increase food security in some areas (Hardouin et al., 2003; Lammers et al., 2009) .

In fact, guinea pig (20.3% of CP) has been the meat source for the poorest people in Los Andes mountains for 3000 years. They are able to convert kitchen scraps and garden waste into meat (Hoffman and Cawthorn, 2013). In the other hand capybara and nutria are good sources of animal protein (21 – 22% CP) and they are raised in Latin America (Hoffman, 2008). Chinchilla meat has less CP than these rodents' meats, but it is important to bare in mind that the main objective in chinchilla industry is the fur, and meat is a by-product of this industry. From this point of view, chinchilla meat despite having lower protein content than others rodents meat, it could become an interesting source of protein. Fat content of chinchilla (ether extract) showed that this meat is leaner than bovine meat (table 3). That could be a positive aspect, because nowadays consumers are more concerned about fat contents and fat profiles of different foods, especially those of animal origin, since it is well known that fat and fatty acid profile are related with some kinds of diseases. Following the last idea, more important that fat level, is the fatty acid profile, because some types of fatty acids are healthier than others. Polyunsaturated fatty acids (PUFA) are healthier than saturated fatty acids (SFA).

Table 2. Nutrient composition in traditional and non traditional meats

	Species	Scientific name	n	Nutrient				Reference
				Moisture	Protein	Fat	Ash	
Traditional meat	Bovine	*Bos spp.*	3	67.0	19.22	9.8	0.9	Moreira el al., 2003
	Chicken	*Gallus gallus*		75.4	18.9	3.3	0.9	Hautrive et al., 2012
	Pork	*Sus domesticus*		75.0	21.3	1.3	1.1	Hautrive et al., 2012
Non traditional meat (rodent)	Chinchilla	*Chinchilla laniger*	8	73.7	19.1	6.1	1.1	
	Guinea pig	*Cavia porcellus*		70.6	20.3	7.8	0.8	Rosenfeld, 2008
	Viscacha	*Lagostomus maximus*		73.1	23.9	3.7		Arellano et al., 1993
	African giant rat	*Cricetomys gumbianus*		65.40	20.1	11.4	2.0	Oyarekua and Ketiku, 2010
	Nutria	*Myocastor coypus*	4	69.5	20.9	2.2	4.0	Cabrera et al., 2007
	Nutria	*Myocastor coypus*	42	75.7	22.1	1.3	1.0	Tulley et al., 2000
	Nutria	*Myocastor coypus*	5	73.8	21.0	1.6	-	Saadoun et al., 2006
	Capybara	*Hydrochoerus hydrocaeris*	13	75.6	22.0	1.8	1.1	Oda et al., 2004
	Capybara	*Hydrochoerus hydrocaeris*	7	76.2	22.3	1.0	1.1	Oda et al., 2004
	Capybara	*Hydrochoerus hydrocaeris*	18	74.4	20.9	1.8	1.2	Girardi et al., 2005

Table 3. Fatty acid composition (% of total fatty acids) of meat from different species.

Fatty acid	Species			
	Chinchilla	Guinea pig (a)	Nutria (b)	Capybara (c)
Lipid (g/100g)	6.1	7.8	1.8	1.8
Saturated				
12:0	0.08	-	-	-
14:0	1.60	1.59	3.60	2.00
15:0		0.29		
16:0	16.56	21.82	21.90	22.40
17:0	-	-	0.40	1.40
18:0	3.13	9.60	8.40	6.30
20:0	0.05	0.14	0.10	-
Total	***21.42***	***33.44***	***34.40***	***32.10***
Mono-unsaturated				
14:1	0.13	0.30	-	-
16:1	4.98	1.34	8.90	2.10
17:1	-	-	0.40	1.50
18:1	28.58	13.77	27.50	26.20
20:1	0.27	0.03	0.30	0.70
Total	***34.0***	***15.44***	***37.1***	***30.50***
Poly-unsaturated				
18:2	36.23	20.01	21.30	28.60
18:3 n6	0.04	0.24	-	2.70
18:3 n3	3.34	25.17	-	-
20:2	0.24	0.21	0.30	-
20:3 n6	0.10	0.19	-	0.10
20:3 n3	0.03	0.41	-	-
20:4	0.12	2.18	1.80	-
22:5	0.02	1.54	0.20	-
22:6	0.07	0.72	0.10	-
Total	***40.20***	***50.67***	***23.70***	***31.40***
S/MUFA	0.63	2.16	0.93	1.05
S/PUFA	0.53	0.65	1.45	1.02
MUFA/PUFA	0.85	0.30	1.57	0.97

a Kouakou et al., 2013, b Girardi et al., 2005, c Saadoun et al., 2006

Chinchilla meat had high content of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), specifically the essential linoleic acid. When comparing chinchilla meat with others rodent meat (table 3), chinchilla meat has less SFA than guinea pig, nutria and capybara, similar monounsaturated fatty acid (MUFA) than nutria and capybara and more PUFA than nutria and capybara. Guinea pig has a little bit different fatty acid profile, because they have similar content of fat as chinchilla, but they have low content of MUFA (15.4%) and high content of PUFA (50.6%). Because rodents are non-ruminats, feed ingredients and fat source of the diet influence fat profile. If the diet is more unsaturated it is expected that meat fatty acid profile could be more unsaturated. More research is needed to learn about modify fatty acid profile through feeding handling.

Since the number of samples in the aforementioned studies (including ours) is small; we can only use them as descriptive studies contributing to the knowledge of different non-traditional meat.

As found by Echalar et al., (1998), chinchilla meat derivatives showed less water content than raw meat, probably because of dehydration and lower water holding capacity due to processing (Table 4). Derivatives showed increased protein content, probably due to a lower water holding capacity and because of the formation of a toast barrier which prevents loss of this nutrient (Cheftel et al., 1989).

Table 4. Nutritional value of chinchilla meat products

	Oil Confit	Lard Confit	Baked-Smoked Chinchilla
Water (%)	53.66	56.67	56.7
Fat (%)	8.67	11.34	16.48
Protein (N*6.25)	24.67	23.62	20.04
Minerals (%)	10.55	7.60	5.68
Non N extract (%)	2.45	0.77	1.10

Tasting trials with the different preparations of Chinchilla meat, showed that the baked-smoked chinchilla was perceived as a meat with a good color intensity, aroma and flavor and low bitterness (Table 5). The Confit was perceived as a meat with adequate aroma, flavor and fattiness, a little salty, with low bitterness and color intensity.

Table 5. Organoleptic characteristic of some derivates of chinchilla meat

Descriptor	Baked leg	Smoked loin	Oil Confit	Lard Confit
Appearence	11.0	7.7	7.7	8.5
Color Intensity	8.8	9.0	6.2	7.1
Aroma	8.9	9.9	7.1	7.3
Salty	10.1	8.0	9.9	10.8
Flavor	10.1	9.4	8.8	9.2
Bitterness	2.7	1.9	2.1	3.1
Fattyness	9.1	10.2	8.3	8.3
Hardness	7.7	9.1	--	--

The level of acceptance of Chinchilla meat was good (Figure 3) in accordance to what Echalar et al., (1998) found. Baked-smoked chinchilla (leg and loin) was the most preferred product (83%), followed by confit (62%). Baked leg showed a higher level of preference in the non-trained group rather than in the trained one. Opposite results were obtained for the case of loin evaluation. Vegetable oil and lard confit showed a good level of acceptability in both groups, with the latter being more preferred.

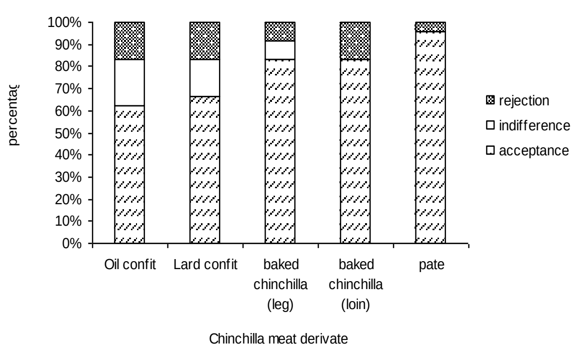

Figure 3. Percentage of acceptance, indifference and rejection of chinchilla meat derivates.

4. Conclusions

From our results we can indicate that Chinchilla meat is a good source of food for human consumption. In fact it can be recommended because: it is an interesting source of poly-unsaturated fatty acids, it has a high level of linoleic acid and a good level of protein

According to Hoffman and Cawthorn (2013) it is likely that there will be an increase in non-traditional meats consume in the future and more research is required on the nutritional component of the meat. Certainly, this study is adding more information about nutritional composition of Chinchilla meat

Finally, in this study tree types of derivatives were evaluated but it is necessary more research and trials to determine the more appropriate derivative of chinchilla meat. The acceptability of chinchilla meat derivatives was very good, however, this is not enough for commercialization and consumer approval. It is necessary to understand that chinchilla meat commercialization (like other exotic meats) is limited by its volume of production. This is the reason why the delicatessen market probably will be a good store for this kind of meat.

5. References

Adaro, L., Orostegui, P., Olivares, R., and Villanueva, S. (1999). Morphometric variations in male reproductor system in chinchilla in captivity through a year. *Avances Producción Animal (Chile)*, 24: 91-95.

Antonio, S. d. D., Velho, J. P., Carvalho, P. A., Backes, A. A., Sanchez, L. M. B., and Velho, I. M. P. H. (2007). Body composition prediction and net macroelements requirements (Chinchilla lanigera). Ciência e Agrotecnologia, 31: 548-553.

Cabrera, M., Del Puerto, M., Olivero, R., Otero, E., and Saadoun, A. (2007). Growth, yield of carcass and biochemical composition of meat and fat in nutria (*Myocastor coypus*) reared in an intensive production system. Meat science, 76: 366-376.

Cheftel, J.-C., Lorient, D., and Cuq, J. L. (1989). *Proteinas alimentarias: bioquímica-propiedades funcionales-valor nuticional-modificaciones químicas*: Acribia.

Echalar, S. R., Jiménez, M. J. M., and Ramón, A. N. (1998). Valor nutritivo y aceptabilidad de la carne de chinchilla. Archivos latinoamericanos de nutricion 48: 77-81.

Firestone, D. (1989). Official Method Ce 1b-89. *Official Methods and Recommended Practices of the American Oil Chemists' Society*.

Girardi, F., Cardozo, R. M., de Souza, V. L., de Moraes, G. V., dos Santos, C. R., Visentainer, J. V., Zarab, R.F. and de Souza, N. E. (2005). Proximate composition and fatty acid profile of semi confined young capybara (*Hydrochoerus hydrochaeris hydrochaeris* L. 1766) meat. Journal of Food Composition and Analysis, 18: 647-654.

Hardouin, J., Thys, É., Joiris, V., and Fielding, D. (2003), Mini-livestock breeding with indigenous species in the tropics. Livestock Research for Rural Development, 15:30.

Hoffman, L. (2008). The yield and nutritional value of meat from African ungulates, camelidae, rodents, ratites and reptiles. Meat science, 80: 94-100.

Hoffman, L. C., and Cawthorn, D. (2013). Exotic protein sources to meet all needs. Meat science, 95: 764-771.

Kouakou, N., Grongnet, J.-F., Assidjo, N. E., Thys, E., Marnet, P.-G., Catheline, D., Legrand P., Kouba, M. (2013). Effect of a supplementation of *Euphorbia heterophylla* on nutritional meat quality of Guinea pig *Cavia porcellus* L.. Meat science, 93: 821-826.

Lammers, P. J., Carlson, S. L., Zdorkowski, G. A., and Honeyman, M. S. (2009). Reducing food insecurity in developing countries through meat production: the potential of the guinea pig (*Cavia porcellus*). Renewable Agriculture and Food Systems, 24: 155-162.

Marinovic, S. (1990). Como criar chinchillas. Nociones básicas. Chile Agrícola, 15:150-151.