UNIVERSITY OF FLORIDA
EXTENSION
Institute of Food and Agricultural Sciences

AN137

Increasing the Profitability of Florida Alligator Carcasses[1]

F.W. Leak, T.J. Lane, D.D. Johnson, J.W. Lamkey[2]

Introduction

The American alligator, *Alligator mississippiensis*, is thought by many to be one of Florida's true natives. This native Floridian has been prized over the years for its commercially valuable skin. In the past, this has unfortunately led to widespread, abusive harvesting of wild alligators that nearly led to their extinction. However, today under strict federal and state scrutiny, the wild alligator is making a strong comeback. Also, today we are witnessing the increase in numbers of "farm-raised" alligators. Unlike their wild counterparts, these animals are raised under controlled conditions and "harvested" for their valuable skin and for their meat.

The farm-raised alligator industry is rapidly growing and the amount of alligator meat available for sale to the public is also growing. Unfortunately, we currently have little information regarding all aspects of alligator processing and the characteristics of the meat itself. Therefore, this study was designed to develop information regarding this subject using the following objectives:

1. To determine the percentages of hide, useable lean meat, fat, and waste of a 6 to 6 1/2 foot gator carcass.

2. To determine the composition of alligator fat and to explore the possible uses of this fat.

3. To develop uses for or products to be made from the residual lean tissue currently being left on alligator carcasses after processing.

Materials and Methods

Ten slaughter-weight gators (5 to 7 1/2 feet) were transported to the University of Florida's Meat Laboratory. The gators were weighed and then exsanguinated by severing the spinal cord at the base of the skull with a knife. The gators were then thoroughly washed, scrubbed with a detergent, rinsed, and sanitized. The carcasses were then suspended tail-up on a hog trolley and rinsed. Half of the carcasses were electrically stimulated (60 volts, continuous impulse, square wave, alternating polarity) by placing one probe in the cloaca and the other in the base of the skull. The carcasses were then weighed and chilled 24 hours at 34°F.

1. This document is AN137, one of a series of the Department of Animal Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published January 2003. Please visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. F.W. Leak, former associate professor, Department of Animal Sciences, University of Florida; T.J. Lane, retired associate professor, College of Veterinary Medicine, University of Florida; D.D. Johnson, Professor, Department of Animal Sciences, University of Florida; J.M. Lamkey, FMC Corporation, Princeton, NJ; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL, 32611.

After chilling, the carcasses were again weighed and measured for girth and length. Girth was measured at four locations; 1) halfway between the inside of the foreleg and the inside of the hindleg, 2) halfway anterior to the midline of these two points, 3) halfway posterior, 4) diameter of the tail measured between the 5^{th} and 6^{th} scute, posterior to the base of the tail. Length was also measured at four locations: 1) snout to eyes - from the tip of the snout to the tip of the base of the eyes, 2) snout to vent - from the tip of the snout to the posterior tip of the vent, 3) snout to tail - from the tip of the snout to tip of the tail, 4) vent to tail - posterior tip of vent to tip of tail.

Microbial samples were obtained by aseptically removing 50-gram samples of lean tissue approximately 1/8 inch deep from the dorsal portion of the shoulder, the ventral portion of the base of the tail and the interior portion of the rib cage. All samples were taken before the carcasses were boned and immediately after they were skinned. Samples were prepared using standard microbiological procedures and enumerated for total counts, *Staphylococcus aureus*, total coliforms, fecal coliforms, *Escherichria coli*, and *Salmonella*. Counts were expressed per gram except for *Salmonella* which was expressed as positive or negative per 25 grams. Microbial analysis was performed at ABC Research Corporation.

Gators were then skinned according to conventional skinning procedures. Each skin was weighed, then fleshed and weighed again. Carcasses were then fabricated and weights recorded for each of seven separate muscle/cut groups; 1) Tailmeat, 2) Tailtender, 3) Tenderloin, 4) Backstrap, 5) Rib, 6) Jowl, 7) Processing meat. All muscle/cut groups were boneless and closely trimmed of fat, except the rib which was bone-in. Bone, fat, head, feet, tongue, heart, liver, and visera weights were also recorded. All meat samples were vacuum packaged using Cryovac B620 barrier bags and frozen at -23° C until needed for analysis.

Proximate analysis was conducted on duplicate samples of tail and processing (body) meat from each gator according to AOAC procedures. Tenderness of tail muscle samples was objectively evaluated using a texturometer equipped with a Kramer shear attachment. The tail muscles were cut in half and each half was cooked to an internal temperature of 160° F in a convection oven set at 350° F. After cooling, two 20 X 40 mm samples were obtained from each tail section and evaluated for tenderness. Tenderness values for each gator were pooled and expressed as lb/g.

Data from all analysis is given in Appendix Table 1. Means and ranges for various carcass characteristics were calculated and correlations between length/girth measurements and meat/fat/bone yields were determined using SAS.

Results and Discussion

Mean values and ranges for carcass components are given in Table 1. Values in this and all other tables (except for microbiological) represent nine gator carcasses. One carcass was obtained from a alligator which was over twice as old and weighed 2 1/2 times the average of the remaining nine alligators used in the study. The researchers conducting this study deemed this alligator to be atypical for the group and removed the cutability data associated with it from the study. Data generated from the microbial analysis was left intact for all ten gator carcasses.

Values and ranges found in Table 1 apply to gator carcasses originating from alligators that weighed an average of 46.7 pounds live, were 5.6 feet from snout to tail, and measured 21.7 inches in girth. Ranges for these measurements are found in Appendix Table 1. The values in Table 1 are valid for alligators that fit within these weight and length/girth ranges. Alligators outside these ranges may or may not conform to the data generated in this study.

The information in Table 1 can be used by the gator processor in several ways. First, it can be used to estimate the value of a particular gator carcass. Secondly, it could be used to estimate the number of alligators needed to meet particular sales needs. The individual processor should be able to use this information in these and numerous other ways.

The relationship of certain carcass measurements to meat yield was evaluated in this study, and the data for length measured from snout to tail and girth measured halfway between the front and hindleg are presented in Table 2. These two measurements seem to be the best length/girth predictors of meat yield. Looking at Table 2, we see a fairly good drop-off in meat yield when gators exceed 23 inches in girth and 70 inches (5.8 feet) length. Animal number 2 is an exception to this because it is only 61 inches in length, therefore, girth is by far our best single indicator of meat yield in this study.

Simple correlation coefficients found in Table 3 support the case for girth being a good indice of meat yield. Examining the data, we see that several of the girth measurements (G, G_3, and G_4) as well as liveweight are highly correlated to meat yield. These are negative correlations, which means that as these measurements increase, meat yield decreases. The point of optimum weight or girth to maximize yield cannot be accurately determined from the data generated by this study. The number of animals studied was too low to draw solid conclusions. However, an educated guess would put it at 5 1/2 to 6 feet, 22 to 23 inches in girth and 45 to 50 pounds.

Two carcasses, numbers 7 and 8, were of similar weights, but had vastly different carcass characteristics. Table 4 shows the comparison of number 7, a slightly shorter, plumper-middled gator, to number 8 a longer, thinner gator. If we were looking at types of beef cattle, we would expect number 7 to yield a lower percent of meat and a higher percent of fat, with bone constant or slightly higher, based on its body type. The data bear out this prediction. Number 7, an earlier maturing, shorter, wastier-type gator, yields less lean meat and more waste fat. This information could be of use somewhere in the future when selecting gators for breeding herds versus slaughter gators.

Another interesting point when comparing numbers 7 and 8 is the percent residual. Number 8, the higher cutability gator, has a greater percent of residual and a greater percent of hide. It would be expected for number 7 to have a greater percent residual since its girth is nearly 2 inches larger. An accurate explanation for this can not be given at this time.

Table 5 shows the compositional means and ranges for alligator tail and body meat. Moisture content of the tail and body meats is high compared to red meats and poultry. In beef, water ranges from around 50 to 70% and in poultry from 65 to 72% of fresh weight, whereas in alligators, from 70-77% of fresh weight is water. This high moisture content is a direct result of alligator tail and body meat having a very low fat content (3.11, and 4.95, respectively). The high moisture content makes this a delicate product susceptible to freezing damage which would result in excessive amounts of "drip-loss" during thawing. Alligator meat must be frozen at a fast rate to prevent this! The low fat content is a positive factor in light of today's increasing number of health-conscious consumers. Alligator meat is a low-fat food. Unfortunately, the type of fat present is not extremely desirable and we will discuss that later in the paper.

Protein content is high in alligator meat, ranging from 21.2% for tail meat to 18.9% for body meat. Beef protein, by contrast, ranges from around 15 to 20%. Ash content was around 1%, which is characteristic of other meat products.

An evaluation of alligator fat revealed that it is a highly unsaturated greasy fat that is somewhat similar to pork fat. Table 6 shows a comparison of alligator, pork, and beef fat. From this, we see that alligator fat was quite a bit higher in unsaturated and lower in saturated fat than beef and pork. From one standpoint this was good because the level of saturated fats in the diet is being criticized by many doctors and nutritionists. So, meat that is lower in saturated and higher in unsaturated fat would be desirable from a nutritional point of view. On the other hand, unsaturated fats are much more susceptible to oxidative rancidity. This results in off-flavors in both the meat and the fat that are detrimental to the product's quality. Alligator meat is very susceptible to this reaction. To prevent or at least slow down this reaction, you must remove all the oxygen from the bag in which the meat is stored, since without oxygen, this reaction does not occur. Vacuum packaging is the answer to this situation.

Comparing certain alligator fatty acids to those in beef and pork (Table 6), we see that alligator fat is fairly unique. It's higher in linoleic than both beef and pork but lower in palmitic and stearic. This difference shows that alligator has its own unique type of fat. The effect of diet and environment on flavor and fatty acid percentages need further study.

The possibilities for commercial uses for alligator fat are broad, ranging from edible to inedible. In this study, only the edible possibilities were explored. During the product development part of this project, to be discussed later, it was found that around 10 to 12% of the alligator fat that is currently being removed can be incorporated into processed alligator meat products. This can have a tremendous impact on yields of "processing meat" and substantially increase the value of the alligator carcass. Further investigation of the commercial uses of fat will be done in our next project.

Results of the microbial examination are given in Table 7. Overall the results are very encouraging. Total counts at all three locations are relatively low except for the tail of one gator which had counts much higher than the other nine. When this sample is removed, the average total count drops from 11,802/g to 891/g. The adjusted figure is more realistic and is very acceptable for a raw meat product.

All other counts were extremely low and well within acceptable limits except *Salmonella*. Five out of thirty samples tested positive for *Salmonella*, (16.7%). This is not extremely high, when compared to raw chicken, but is not something to be taken lightly either. *Salmonella* is everywhere in the environment, so special care should be taken when handling the raw product, and a strict sanitation program for equipment and personnel should be developed and implemented at every processing facility. In addition, alligator meat should be fully cooked (160° F internal temperature) to ensure the destruction of any possible microbial problem. *Salmonella* must be ingested live to cause illness in humans, therefore there should be no problem as long as the product is cooked and handled properly.

Results of the effect of electrical stimulations on tenderness of the gator tail muscle are found in Table 8. ES did improve tenderness slightly, although the improvement was not significantly ($P<0.05$) different from the non-stimulated alligators. The lower value (23.6 versus 28.6) is indicative of a more tender sample although little can be drawn from this data because of small sample numbers and a great deal of variability between samples. At this time ES does not seem to be a practical or useful application in the processing of alligator carcasses. However, in the future, large processing facilities may find a use for ES, but more research would need to be done before recommendations could be made.

The tenderness data generated on the five non-stimulated gators is useful information. It gives a baseline for tenderness to compare with other treatments or larger/older gators. For example, is the tenderness of mature alligator tail comparable to that of younger, slaughter-weight gators?

The final objective of this project was to develop some new products that could be made with the residual lean now being left on alligator carcasses. Numerous types of products were formulated and attempted; some successes, some failures. The successes included a "Gator Nugget, Gator Jerky, Gator Sticks (a fermented slim jim-type product), and Gator Ribs (a pre-cooked full rib product). All of these were served at the American Alligator Farmer's Association meeting held at the University of Florida, July 1987. Response was extremely favorable to all of them.

The fermented sticks, jerky, and possibly the nuggets have the best chance to make it in the market. Currently, we are working on getting one or more Florida processors to begin manufacturing and marketing one of these products.

Conclusions

1. Alligator meat from Florida farm-raised alligators is a high quality food product that is high in protein and low in fat. When properly handled and prepared, it is a safe, wholesome, nutritious food product.

2. Yields of various carcass components vary from alligator to alligator. However, means and ranges for these components have now been established for 5 1/2- to 6-foot farm-raised slaughter gators.

3. The fat tissue of alligator carcasses is highly unsaturated. This fat is susceptible to oxidative rancidity and all alligator meat products that contain fat should be stored in the absence of oxygen or treated with antioxidants.

4. Alligator fat can be incorporated into processed products at a level of 10 to 12% with no effect on product quality.

5. The lean residual tissue on a alligator carcass can be removed and formulated into processed products that have a great deal of market potential.

Acknowledgements

Our sincere appreciation is expressed to members of the American Alligator Farmer's Association for their financial support of this project. Special appreciation is extended to Mr. Tracy Howell for sharing with us his guidance and expertise in processing alligators. We are also indebted to Mr. Bob Wynne and Mr. Bill Tuley of ABC Research, Inc. for assistance and guidance on the microbial and product portions of this project.

Animal #	1	2	3	4	5	6	7	8	9			
Totals per individual (HCW basis)										RANGE		MEAN
Meat	43.13%	40.68%	39.37%	40.44%	45.04%	46.29%	42.31%	42.63%	47.12%	39.37%	47.12%	43.00%
Bone	12.03%	12.78%	12.89%	14.95%	12.53%	13.68%	13.50%	12.12%	11.46%	11.46%	14.95%	12.88%
Fat	12.83%	11.75%	11.07%	13.33%	9.37%	6.91%	12.04%	7.37%	7.93%	6.91%	13.33%	10.29%
Resid.	30.83%	32.89%	33.64%	29.05%	32.28%	31.47%	31.94%	35.86%	32.56%	29.05%	35.86%	32.28%
Totals per individual (LW basis)										RANGE		MEAN
Meat	41.74%	39.46%	38.73%	39.31%	43.39%	44.34%	40.73%	41.54%	44.93%	38.73%	44.93%	41.57%
Bone	11.65%	12.40%	12.68%	14.54%	12.07%	13.10%	12.99%	11.81%	10.93%	10.93%	14.54%	12.46%
Fat	12.42%	11.40%	10.89%	12.96%	9.02%	6.62%	11.59%	7.19%	7.56%	6.62%	12.96%	9.96%
Resid.	29.84%	31.90%	33.09%	28.24%	31.10%	30.14%	30.75%	34.94%	31.05%	28.24%	34.94%	31.23%

Lengths:
- L-1 Snout to eyes
- L-2 Snout to vent
- L-3 Snout to tail
- L-4 Vent to tail

Girths:
- G-1 ½ way – fore & hind legs
- G-2 ½ again anterior
- G-3 ½ again tail
- G-4 Diameter of tail

Treatment:
1) Non-stimulated
2) Electrically stimulated

Farm	1	2	3	4	5	1	2	3	5			
Trt	1	1	1	1	1	2	2	2	2	RANGE		MEAN
LW	31.00	50.00	61.50	54.00	41.00	35.50	53.50	50.80	43.00	31.00	61.50	46.70
HCW	30.00	48.50	60.50	52.50	39.50	34.00	51.50	49.50	41.00	30.00	60.50	45.22
CCW	29.30	47.45	59.00	51.10	39.20	33.60	50.60	48.30	40.45	29.30	59.00	44.33
ACW	29.74	48.22	60.21	52.25	39.22	33.74	51.23	49.20	40.72	29.74	60.21	44.95
L1	10.90	12.70	15.88	13.65	13.65	12.38	14.92	15.24	13.97	10.90	15.88	13.70
L2	73.30	86.68	99.06	84.77	87.00	81.60	92.08	93.66	83.19	73.30	99.06	86.82
L3	145.40	154.94	193.40	183.20	167.96	161.29	178.12	183.20	171.45	145.40	193.40	171.00
L4	72.40	68.26	94.30	93.98	81.92	80.01	88.58	89.85	86.36	68.26	94.30	83.96
G1	47.00	60.01	58.74	63.82	53.98	49.53	58.10	53.34	53.34	47.00	63.82	55.32
G2	42.90	54.93	53.98	57.15	48.26	46.67	52.07	49.21	77.15	42.90	77.15	53.59
G3	45.10	54.61	58.42	61.28	50.17	45.72	56.52	49.53	52.07	45.10	61.28	52.60
G4	41.90	45.72	51.12	49.85	42.23	40.01	46.99	46.04	42.86	40.01	51.12	45.19
Hide-R	14.19%	12.20%	14.72%	12.31%	13.90%	13.94%	11.96%	15.85%	12.67%	11.96%	15.85%	13.53%
Hide-C	12.74%	11.00%	13.09%	11.30%	12.44%	11.97%	10.37%	14.47%	11.51%	10.37%	14.47%	12.10%
Head	5.32%	6.60%	6.42%	5.28%	5.98%	5.49%	6.17%	6.79%	5.81%	5.28%	6.79%	5.99%
Feet	3.87%	4.20%	3.90%	2.87%	3.17%	4.37%	4.11%	4.63%	3.49%	2.87%	4.63%	3.85%
Tongue	0.65%	0.50%	0.57%	0.65%	0.61%	0.56%	0.56%	0.59%	0.58%	0.50%	0.65%	0.59%
Heart	0.32%	0.20%	0.16%	0.19%	0.12%	0.28%	0.19%	0.20%	0.23%	0.12%	0.32%	0.21%
Liver	1.13%	1.10%	1.22%	0.83%	0.85%	1.13%	1.12%	1.08%	0.93%	0.83%	1.22%	1.04%
Visc.	4.35%	7.10%	6.10%	6.11%	6.46%	4.37%	6.64%	5.81%	7.33%	4.35%	7.33%	6.03%
B-bone	8.26%	9.30%	8.78%	12.04%	8.29%	9.15%	9.63%	8.17%	7.91%	7.91%	12.04%	9.06%
T-bone	3.39%	3.10%	3.90%	2.50%	3.78%	3.94%	3.36%	3.64%	3.02%	2.50%	3.94%	3.40%
B-fat	6.61%	6.40%	5.85%	4.91%	5.73%	3.10%	6.64%	3.35%	3.84%	3.10%	6.64%	5.16%
T-fat	5.81%	5.00%	5.04%	8.06%	3.29%	3.52%	4.95%	3.84%	3.72%	3.29%	8.06%	4.80%
T-meat	11.61%	10.60%	10.36%	11.17%	12.85%	12.76%	11.16%	10.47%	12.00%	10.36%	12.85%	11.44%
T-ten	3.06%	2.80%	3.01%	2.50%	2.93%	3.38%	3.08%	3.05%	3.37%	2.50%	3.38%	3.02%
T-loin	0.97%	0.90%	0.73%	0.74%	0.98%	0.85%	0.65%	0.79%	0.93%	0.65%	0.98%	0.84%
B-strap	3.23%	3.20%	3.90%	3.33%	4.02%	3.66%	3.46%	3.54%	3.95%	3.20%	4.02%	3.59%
Rib	3.26%	3.76%	3.09%	2.98%	3.93%	3.83%	3.51%	3.23%	3.74%	2.98%	3.93%	3.48%
Jowl	1.13%	1.50%	1.30%	1.48%	1.46%	1.13%	1.50%	1.67%	1.74%	1.13%	1.74%	1.43%
P-meat	17.35%	16.10%	15.28%	16.74%	17.10%	17.32%	16.34%	18.29%	18.95%	15.28%	18.95%	17.05%
T-loss	1.13%	0.60%	1.06%	0.37%	0.12%	1.41%	1.03%	0.49%	0.23%	0.12%	1.41%	0.72%

Appendix Table 1.

Table 1. Ranges and means for carcass components.

Item	Range[a]	Mean[a]
Hide	10.4 - 14.5	12.1
Head	5.3 - 6.8	6.0
Feet	2.9 - 4.6	3.9
Tongue	0.5 - 0.7	0.6
Heart	0.1 - 0.3	0.2
Liver	0.8 - 1.2	1.0
Viscera	4.4 - 7.3	6.0
Bone	11.0 - 14.5	12.5
Fat	6.6 - 13.0	10.0
Tailmeat	10.4 - 12.9	11.4
Tailtender	2.5 - 3.4	3.0
Tenderloin	0.7 - 1.0	0.8
Backstrap	3.2 - 4.0	3.6
Rib	3.0 - 3.9	3.5
Jowl	1.1 - 1.7	1.4
Processing meat	15.3 - 19.0	17.1
BNLS Meat	38.7 - 44.9	41.6

[a]Values expressed as a percentage of liveweight.

Table 2. Relationship of length and girth to meat yield.

Animal #	Girth, in	Length, in	Meat Yield, %
			(LW Basis)
1	18.5	57.2	41.7
6	19.5	63.5	44.3
8	21.0	72.1	41.5
10	21.0	67.5	44.9
5	21.3	66.1	43.4
7	22.9	70.1	40.7
----	----	----	----
3	23.1	76.1	38.7
2	23.6	61.0	39.5
4	25.1	72.1	39.3
9	35.0	84.5	41.1

Table 3. Simple correlation coefficients for various carcass measurements with meat, fat, and bone percentages[a].

Measurements[b]	Meat, %	Fat, %	Bone, %
L_1	-0.30	-0.17	0.09
L_2	-0.47	-0.09	0.16
L_3	-0.36	-0.06	0.33
L_4	-0.19	-0.06	0.35
LW	-0.73**	0.28	0.40
G_1	-0.71**	0.49	0.62*
G_2	0.21**	-0.17	-0.25
G_3	-0.70**	0.54	0.58*
G_4	-0.86**	0.53	0.49

[a]Values expressed on a percent liveweight basis.

[b]L_1 = snout to eyes, L_2 = snout to vent, L_3 = snout to tail, L_4 = vent to tail, LW = liveweight, G_1 = 1/2 way-fore and hindleg, G_2 = 1/2 again anterior, G_3 = 1/2 again posterior, G_4 = diameter of tail.

*Values within columns are significant (P<0.10).
**Values within columns are significant (P<0.05).

Table 4. Yield comparison.

	#7	#8
Live weight, lbs	53.5	50.8
Length, in	70.1	72.1
Girth-1, in	22.9	21.0
Girth-2, in	22.2	*19.5
Meat[a], %	40.7	*41.5
Fat[a], %	11.6	7.2
Bone[a], %	13.0	11.8
Residual[a], %	30.1 (10.4)[b]	*34.9 (14.5)[b]

[a]Values expressed as a percent of liveweight.
[b]Percent cleaned hide weight.

Table 5. Composition of alligator tail and body meat.

	Tail Meat	Body Meat
Moisture, %	74.6	74.8
Range	70.8 - 77.0	70.0 - 76.9
Protein, %	21.2	18.9
Range	18.3 - 23.2	17.8 - 20.2
Fat, %	3.11	4.95
Range	1.03 - 9.88	1.84 - 10.98
Ash, %	1.07	1.38
Range	0.99 - 1.16	0.40 - 2.15

Table 6. Fat comparison.

	Beef	Pork	Alligator
Saturated, %	53	44	31
Unsaturated, %	47	56	69*
Palmitc, 16:0, %	17.7	19.4	15.6
Stearic, 18:0, %	8.8	11.4	4.5
Oleic, 18:1, %	26.9	38.4	29.6
Linoleic, 18:2, %	1.5	9.5	11.4

Table 7. Microbiological analysis.

	Tail	Shoulder	Rib
Total Counts, gm	11,802 (891)[a]	390	145
Staph Aureus, gm	<3	<3	<3
Total Coliforms, gm	4	<3	5
Fecal Coliforms, gm	<1	<1	<1
E. Coli, gm	<1	<1	<1
Salmonella, 25 gm	3 (+)	1 (+)	1 (+)

[a]Value adjusted by removing counts from one carcass that was considered to be contaminated.

Table 8. Effect of electrical stimulation on tenderness of alligator tail muscles.

Treatment	N	Tail muscle[b]
Stimulated	5	23.6
Non-stimulated	5	28.6
$\bar{X}$	10	26.0

[a]Samples expressed as lbs/g.
[b]Treatments were not different (P>.05).