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Pond type and pre-tanning processes affect size and quality of captive Nile crocodile skins

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ABSTRACT

The skin of *Crocodylus niloticus* is one of the best among alligator species. Understanding proper rearing of crocodiles and processing of their skins is very essential for farmers because quality is very crucial in marketing the skins. A study was done to assess the effects of processing stages and pond type on crocodile skin size and quality. A total of 400 skins were assessed, of which 200 skins were from each pond. The skins had their belly sizes measured before and after being subjected to the processing stages. The skins were also graded in terms of quality after every stage. Data analysed using a paired t-test for initial and final skin size within and across ponds showed that there was a significant (P =0.00) effect of pond type on both initial and final skin size. Earth ponds showed high skin size but had a low quality compared to cement ponds. Further, there was a significant effect of processing stages on final quality (P value =0.00). The conclusion of the study was that crocodile rearing environment and skin processing techniques influence final size and quality of skins. As such, it was recommended that producers monitor rearing conditions and pre-tanning processing stages in order to improve skin quality, minimise losses due to shrinkage and thus maximise profits.

1. Introduction

The Nile crocodile (*Crocodylus niloticus*) is widely distributed across Africa (Fergusson, 2010) and has always been in conflict with humans because of the damage they cause on property (livestock) or people (Fergusson, 2010; Campbell *et al*., 2014). However, amidst such a high conflict magnitude where crocodiles attack humans and livestock as prey (Campbell *et al*., 2014), there has been widespread economic exploitation of the species to the advantage of humans. Several countries have been successful in crocodile skin trading. Due to dwindling numbers of crocodiles in the wild and their listing by CITES in Appendix I by 1975 in various countries (Van Jaarsveldt, 1982; Thorbjarnarson, 1999) there was an urgent need to take appropriate measures that guarded against extinction of species. As such, conservationists ventured into the conservation of young crocodiles (Blake & Loveridge, 1975) and trade was only permitted for captive-bred animals (Huton *et al*., 2002; Dzomba *et al*., 2008; Thorbjarnarson, 1999). As Revol (1994) stated, crocodiles were conserved mainly for tourist attraction purposes but gradually their numbers in captivity exceeded those required for tourism. In 1983, the species was delisted from Appendix 1 (Hutton & Child, 1989) and this subsequently led to a rebound of crocodile farming for commercial purposes anchored by the high value of skin. Crocodile farms began to flourish and most of them as outlets for by-products from the poultry processing plants. In comparison to the hide value of other Crocodilian species, the Nile crocodile is ranked second on the world market after the estuarine crocodile, *Crocodylus porous*., (Revol, 1994). Some of the countries that have been involved in trade on various crocodile species include United States of America, Mexico, Australia, Malawi, South Africa and Zimbabwe among many others (Huton, *et al*., 2002)

Thorbjarnarson, (1999) stated that Zimbabwe is one of the countries that pioneered and promoted the ranching of Nile crocodiles. The country practised both ranching and captive breeding (Huton *et al*., 2002; Dzomba *et al*., 2008; Thorbjarnarson, 1999; Fergusson, 1992) and exploitation of wild populations through harvesting of eggs is still being practiced. Thorbjarnarson, (1999) further highlighted that there were many farms that turned into crocodile farming hence more than 50% of annual skin produced once came from farmed animals. Crocodile farming developed rapidly in Zimbabwe from 1986-1990 earning the country significant revenue (Morpurgo *et al*., 1993), to fill the demand from the leather industry. Crocodile farms increased due ranching emphasis promoted by CITES as the preferred means of obtaining conservation benefits from crocodile utilization (Caldwell, 2011; Ross, 1998). These farmers are concentrated around towns such as Harare, Chiredzi and along Lake Kariba as well as in Victoria Falls and are represented by the Crocodile Farmers Association of Zimbabwe.

As a result of increasing numbers of crocodile farms around the world (Caldwell, 2011) and subsequent increases in the numbers of classic skins mainly from the Nile crocodile (*C.niloticus*) and the American Alligator (*Alligator mississippiensis*) on the international market, grading standards have become stricter. Emphasis shifted from quantity of skins produced to a stricter quality assessment of the skins on the market (Van Jaarsveldt, 1982; (Huton *et al*., 2002). A great transformation in crocodile farming industry has occurred since the 1990s in that many skins that previously would have passed as first grade currently no longer do. Some of the problems affecting skin quality such as physical damage, nutritional defects, preservation condition of the skin, proficiency of skinning and fleshing that arise during processing have become significant parameters that affect the size and quality of crocodile skins (Arbeid, 2006). Developing countries, which are the major source of skins in the global market, find it difficult to produce high quality skins required by a luxurious market (Huton *et al*., 2002).

Attempts to improve the quality of skins are aimed at reducing the occurrence of the afore-mentioned defects and physical damages, through improved raising facilities thus avoiding the downgrading of skins. Grading of the skins depends upon the holes, scars, or lesions in the area of prime importance known as the 'pattern'. Downgrading to second quality implies a 25% loss in value and the most serious damage leads to the third grade with a further 25% loss in value (Hutton and Webb, 1990).

Moreover, housing in most crocodile farms does not conform to international standards while in some farms the reptiles are reared in earth ponds where stocking densities are very high. High stocking densities cause bullying especially during feeding (Morpurgo *et al*., 1993) and skin damage to crocodiles resulting in downgraded skins. Earth ponds also possibly have other objects like plants and rough surfaces that damage the skin.

As the crocodile industry continues to grow, there is need to support production through scientific research to enable sound decision making on rearing and processing procedures to promote profit maximisation. However, not much research has been done in Zimbabwe on crocodile housing and the effects of high stocking densities on skin quality. Additionally, no research has compared the captive rearing environments and processing stages of the

Nile crocodile skins. Therefore, the objectives of this study were to assess the effects of crocodile housing type and skin processing stages on the final quality of crocodile skins. The findings of this study will assist the crocodile farmer in producing and processing skins in a way that best suits the market as well as prevent drastic losses on the profits.

2. Materials and methods

2.1. Study site

The study was carried out at Mimosa Park Farm located 32 km out of Bulawayo along Bulawayo-Tsholotsho Road. The area is characterised by distinct wet and dry seasons with a mean annual rainfall of 610 mm. The wet season runs from mid-November to mid-March with little or no rainfall during the rest of the year. The coldest month is June with a mean temperature of 15.30C and the hottest month is October with a mean temperature of 23.40C.

2.2 Data collection and analyses

The crocodiles (*Crocodylus niloticus*) were randomly picked from two different pond types (the earth and cement floor ponds), all aged 2-3 years, which is the slaughter stock age. Harvested skins underwent processing stages namely, flaying, fleshing and curing. After every stage the skins were assessed and graded according to physical damages, condition and preservation of the skin and proficiency of skinning and fleshing. Belly skin sizes were also measured on a fresh skin basis and later on a cured skin basis to observe changes in skin sizes. Twenty skins were randomly selected every two weeks for a month from 200 skins that were marketed from each pond type. This was done from the second week of November 2013 until March 2014.

Cuts or holes (CH), scars or scratches (SR), buttons (double scaling) (B) and missing legs (L) were parameters used in assessing skins for quality and respective symbols were used. The Quality Index or Score (Q.I) for each skin was calculated basing on the total score of a reject skin (Reject skin quality score; CH-3, B-9, L-3, SR-5: total=20) and then the resulting Q.Is for each skin were averaged and converted to percentages. As such, the higher the percentage of the QI, the higher the quality of the skin.

A randomised complete block design was used and each skin was subjected to all consecutive treatments once. The blocking factors were the pond types (earth and cement floor ponds) and the processing stages (skinning (flaying), fleshing and curing) were the treatments. The 400 skins comprised of a group of 200 skins from each pond. The initial mean belly size from the 400 marketed skins before processing was 30 cm. The paired t-test statistic was used to compare means using Minitab Version 14 (2012).

3. Results

3.1. Pond type assessment

Generally, all skins showed a decrease in size as processing stages progressed. However, skins from the earth ponds showed a large percentage loss in size compared to skins from the cement ponds (Table 1). The mean percentage loss of 4.7 % and 8.4 % was recorded in cement and earth ponds respectively. Skins from cement ponds generally showed smaller percentage losses. Using the paired samples t-test, for the pond type assessment showed a significant effect ($p= 0.00$) of rearing method on skin size.

3.2. Skinning effects on skin quality

There was a notable percentage of first grade skins (68%) from the cement or concrete ponds whereas only 4 % of skins from the earth ponds where in this grade after the first processing stage. There was an insignificant difference in the upper second grade composition between the two pond types, that is, 23% from cement ponds and 22% from earth ponds. Half of the earth pond skins were in the lower second grade after skinning whereas this grade had 9% of the cement pond skins. Nearly a quarter (24%) of the earth pond skins were in the third grade and only about 1% of the cement pond skins were in the third grade after skinning. There was no reject skin from the

cement pond but around 1% of the earth pond skins were rejects. There were no putrid skins observed after this stage.

Table 1
Comparisons of skin size of Nile crocodiles raised in cement and earth ponds.

	Cement Pond Skins			Earth Pond Skins		
	Initial belly size (cm)	**Processed skin belly size (cm)**	**Percentage loss [skin Size (%)]**	**Initial belly size (cm)**	**Processed skin belly size (cm)**	**Percentage loss [skin Size (%)]**
	28	27	3.6	29	28	3.5
	26	25	3.9	36	32	11.1
	28	27	3.6	35	31	11.4
	26	25	3.9	34	30	11.8
	29	27	6.9	32	30	6.3
	28	26	7.1	31	29	6.5
	27	25	7.4	30	28	6.7
	29	28	3.5	32	28	12.5
	27	26	3.7	30	28	6.7
	29	28	3.5	32	30	6.25
	29	28	3.5	34	31	8.8
	27	26	3.7	38	34	10.5
	29	27	6.9	35	31	11.4
	27	26	3.7	29	28	3.5
	29	28	3.5	29	28	3.5
	28	27	3.6	32	30	6.7
	27	26	3.7	37	33	10.8
	26	25	3.9	36	33	8.3
	34	31	8.9	35	32	8.6
	30	28	6.7	36	33	8.3
Mean	28.2	26.8	4.7	32.9	30.2	8.2
Std dev	1.8	1.5	1.8	2.9	2.0	2.9
SE	0.4	0.3	0.4	0.6	0.4	0.6

Std dev-standard deviation; SE-standard error of the mean.

3.2. Fleshing effects on skin quality

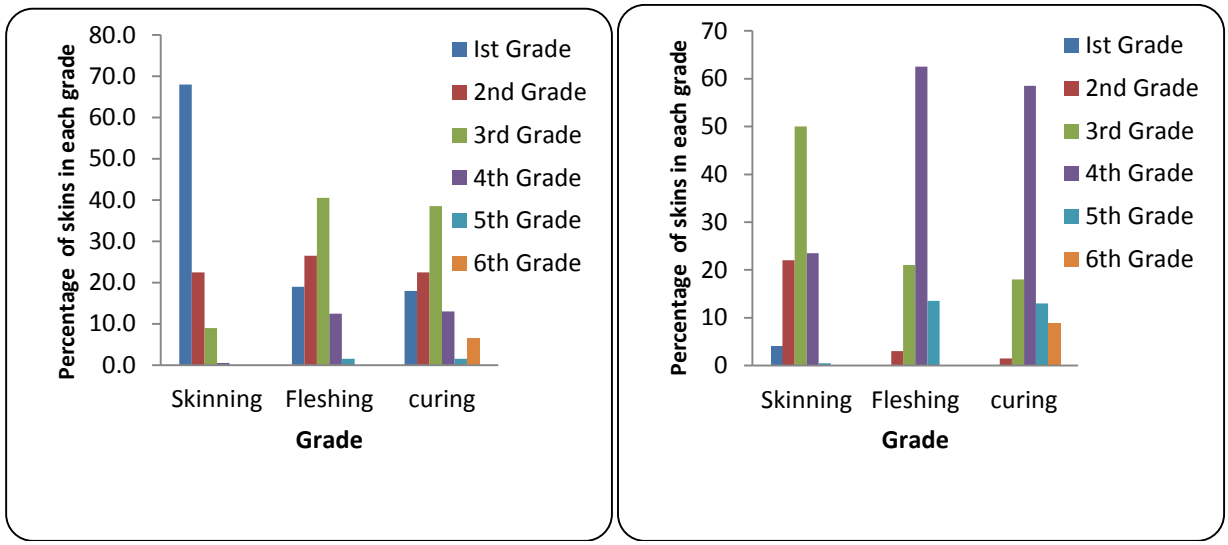
A decline of first grade skins was observed on the cement ponds from 68% to 19% whereas from the earth ponds there were no first grade skins (Figure 1). The upper second grade was around 27% from the cement pond after this stage, whereas from the earth ponds there was a huge decrease of this grade to 3%. There was a great increase in the lower second grade from cement pond skins to 41% from 90% and a huge drop in this grade from the earth pond from 50% to 21%. The study revealed that 13% of cement pond skins were in third grade while there was a huge increase in this grade from 24% to 63% from the earth pond skins. A small fraction (2%) became rejects from the cement pond whereas 14% from the earth pond were rejects after this stage. Both pond skins did not become putrid up to this stage of processing.

3.2. Curing effects on skin quality

After this stage, there were no first grade skins from the earth pond whereas only 18% were first grade from the cement pond. The upper second grade skins were 23% of the total skins from the cement pond and 2% from the earth pond. Most of the cement pond skins became lower second grade (39%) whereas most of earth pond skins became third grade (59%) after this stage. There was an increase in the rejects from the earth pond skins from 0% to 9% while only 2% were rejects from the cement pond skins. There were no putrid skins from both pond

types in the first two stages, but at the end of curing, there were 7% and 9% from putrefied skins from cement and earth ponds respectively.

However, a significant difference of means (p=0.00) was observed after skins had undergone the processing stages resulting in a mean final size of 28 cm using the Paired Samples t-test.



(a) (b)

Fig. 1. Effects of processing stages on skin quality (a) cement pond (b) earth pond for the Nile crocodile in captivity.

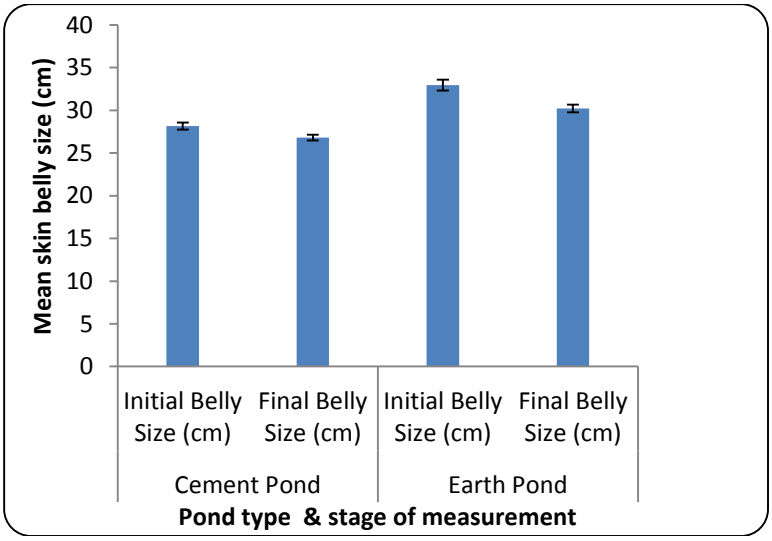


Fig. 2. Mean belly size of skins from cement and earth ponds

Initial belly sizes were generally greater than the final sizes after processing (Table 1). At 95 %, level of confidence there was a significant effect of the pond type on skin sizes. There was a significant effect of processing stages on final quality (P value =0.00). Further analysis showed that there was a statistical significant effect of pond type on the final skin quality ($P < 0.05$).

4. Discussion

According to Guthrie-Strachan, (2005) wet-salted skins have a potential of shrinking up to 16% of their sizes hence the curing stage could have caused dehydration of skins as a way of preserving the skins. However, that caused loss of certain skin width (shrinkage) resulting in significant losses in skin size. Our research findings are consistent with Guthrie-Strachan, (2005) where we observed a mean loss in skin size due to shrinkage (Figure 2). From the farmer's side, this percentage loss in skin size has an effect on the profits since wet salted skins are measured to give the priced sizes of the skins per centimetre. Moreover, most crocodile skins are priced according to belly width at present and skins shrink during salting (FAO, 1985).

Furthermore, if the skin is not sufficiently salted (cured), it may become infected with bacteria or fungi (Shanawany & Dongle, 1999) that cause the epidermis of the scales to decay or slip if the decay is intense. According to the results illustrated in Figures 1, there was an emergence of the putrid skins after the curing stage. This clearly shows that the skins were not properly cured and thus were infected by bacteria. As indicated by Shanawany & Dongle, (1999), putrefaction occurs only when the skins are subjected to insufficient curing. The occurrence of putrid skins contributes to profit losses for the farmer, as the skins are disposed right away. As such, skins need to be thoroughly cured and care be taken that there is an even distribution of the salt on the surface.

A drop in skin quality after flaying could be attributed to poor handling during this process. Same sentiments were recorded by Bostid (1983) that during flaying and fleshing, the skins are exposed to physical damages caused by mistakes, wrong cuts or carelessness of the personnel or non-standard equipment used in performing the processing stages. According to Bostid,(1983) many hides and skins are ruined or severely damaged during skinning and even a single hole resulting from a slip of the skinning knife may reduce a hide's value by 25 percent. Therefore, the study shows that both the pond type and processing stages have a significant effect on the final crocodile skin quality.

Due to the effects of mainly flaying and fleshing, the skins are downgraded and hence result in reduced profits for the farmers. Housing (pond type), has an effect on the final quality of the crocodile skins as shown by the results above. These ponds are of different designs. Cement ponds, unlike earth ponds, are designed in such a way that there is no soil or natural surroundings of rough surfaces and vegetation. The skins from earth pond crocodiles could have been depreciated initially by the surrounding area during growth of crocodiles, followed by scratches or even scars during processing. This contributes very much to downgrading of skins compared to those skins from the cement ponds where the crocodiles are always surrounded by smooth surfaces (Hutton and Webb, 1990). In addition, a significant decrease in quality was thus a combination of both pond type condition and the effect of processing on the skins produced from earth pond crocodiles. Skins from cement pond however presented a greater percentage of final quality. Pond design characterised by smooth surfaces allow for higher quality of skins. Hence, these different conditions in the ponds could be the causes of differing crocodile skin qualities.

5. Conclusion and recommendations

Processing stages and pond type influence the resultant crocodile skin size and quality largely. Therefore, it was recommended that there should be a change in the way current processing stages are performed as well as propose a change in the equipment used. To prevent downgrading of skins because of insufficient curing should be minimised by engaging in better preservation methods such as refrigeration. Shrinking of skins that mostly affects the returns of the farmer due to the lost centimetres could also be prevented by use of brining solution to soak skin as a better preservation method.

Moreover, the differences in quality of cement and earth pond skins show that the former are better. Hence, it is proposed that the use of cement ponds be used if quality is to be upheld. It would be interesting to invest in solitary ponds to even improve quality in a much greater way since that allocates space to a single crocodile hence eliminating crowdedness that contributes to the downgrading of skins. Further, it is recommended that skins undergo a pre-tanning process so that they regain their initial sizes.

Furthermore, more studies should be conducted to identify other effects on skin quality and to prove that leather producers will be able to use techniques that stretch and help regain the skin initial size after processing.

Currently processing stages are performed manually. Research on the effectiveness of these tools should be done and investment into proper processing machinery to reduce human error thereby preventing wrong cuts and

holes during processing can be implemented. The equipment used such as the current scrapers should also be changed, at least, to specified blunt knives.

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