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RESEARCH ARTICLE

DETERMINATION OF CAPACITY OF OTOY (*XANTHOSOMA SAGITIFOLIUM*) CONSUMPTION IN JUVENILE GALAPAGOS TORTOISES (*CHELONOIDIS GUNTHERI* AND *CHELONOIDIS VICINA*) BRED IN CAPTIVITY ON ISABELA ISLAND – GALAPAGOS

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ABSTRACT

Galapagos giant tortoises are in danger of extinction (including 4 of the 15 species are already extinct), so their maintenance and conservation in captivity is of utmost importance for the recovery of their wild populations, among which is fundamental the correct feeding of these chelonians that constitute the animal symbol of the islands and by whom they take its name. At the Tortoise Breeding Center of Puerto Villamil at Isabela Island – Galapagos, the feed is exclusively based on otoy, malanga or yautia (*Xanthosoma sagittifolium*), without any dosage or ration for each pen, so to know the capacity of consumption of tortoises is of utmost importance for them, in order not to waste and optimize their use. The aim of the present study was to determine the consumption capacity of Otoy (*Xanthosoma sagittifolium*) that have juvenile Galápagos tortoises reared in captivity on Isabela Island – Galapagos, Ecuador. Thus, tortoises born in captivity and belonging to the Isabela Island species (*Chelonoidis guntheri* and *Chelonoidis vicina*) were distributed in 5 groups, aged between 1 and 4 years, to each group was administered 1, 2, 3 and 4 kg of otoy during the whole investigation, until standardizing the consumption in 2.5 kg. At the end of the investigation, there was no mortality in any of the pens, and the consumption capacity in groups 1, 2 and 3 corresponded to an average of 89.5 g, 81.4 g and 84.6 g of otoy per kg of body weight, respectively. In groups 4 and 5, the corresponding consumption capacity is 76.3 and 90.3 grams of otoy per kg of body weight, respectively. The present study determined that, on average, 75 to 90 grams of otoy (*Xanthosoma sagittifolium*) should be administered for each kg of body weight of juvenile tortoises reared in captivity at the Tortoise Breeding Center of Puerto Villamil.

INTRODUCTION

The Galapagos giant tortoises are the emblematic animals of the islands, who also contributed to the theory of evolution proposed by Charles Darwin (Poulakakis, Edwards, Chiari, & Garrick, 2015), and are currently considered endangered according to the IUCN Red List (IUCN, 2016) and to the Red List of Ecuadorian Reptiles (Carrillo *et al*., 2005), due to the indiscriminate hunting of the whaling fleets, the presence of introduced animals and the action of humans (Márquez, Cayot, & Rea, 1999; Merlen, 1999), including the extinction of five of the 14 species, the most recent in 2012 with the death of the legendary Solitary George (Froyd *et al*., 2014). For this reason, their breeding and successful breeding in captivity, for then releasing them in their areas of origin, are of utmost importance for the conservation and recovery of their wild species. Due to the near extinction of these animals, it was necessary to build breeding centers of giant tortoises, in order that the tortoises can reproduce in captivity, then release them in their areas of origin and thus recover the wild populations of these reptiles, in 1959 the Charles Darwin Research Station

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was established, the Breeder Center in Puerto Ayora (Santa Cruz) and in Puerto Villamil (Isabela Island) in 1990 (Márquez *et al*., 1999; Merlen, 1999). These actions have begun to succeed with the successful repatriation of several tortoises, as in the case of the release to Spanish Island of tortoises reared in captivity (Milinkovitch *et al*., 2004) and even in the replacement of tortoises on Pinta Island, place of origin of the extinct tortoise *Chelonoidis abingdonii*, to improve the ecological niches in that island, with the use of sterilized Galapagos tortoises belonging to other islands (Hunter, Gibbs, Cayot, & Tapia, 2013). To maintain the health of animals in captivity, it is necessary to provide a correct diet, which must be varied (Beynon & Cooper, 1999) and balanced, as the growth, maintenance and reproduction of captive reptiles depend on several factors, one of which is food (Parham, 2008). The ideal is to provide captive animals with a diet very similar to what they have available in their natural state, but if not possible, it is necessary to provide animals with well-formulated diets to avoid nutritional deficiencies (Kirkwood, Rodríguez, Rengifo, & Nassar, 1999).

Galapagos giant tortoises are exclusively herbivorous animals capable of eating large numbers of plants with a preference for herbs, fruits and cacti (Márquez *et al*., 1999); they feed less frequently and require less food and water than mammals, but when they are available, they can eat a large amount of food (Jackson, 1997). Almost all tortoises eat the food provided, regardless of whether it is palatable or nutritious, due to their instinct for curiosity (Márquez *et al*., 1999). Galapagos tortoises are able to adapt their growth to their feeding conditions, due to their particular phenotype that allows them to increase their weight by 3000 times from birth to adult (Furrer S, Hatt Jean, Snell H, Márquez Cruz, Honnegger R, 2004), due to their ability to adapt their body size according to their habitat (Jaffe, Slater, & Alfaro, 2011). They store water, which allows them to survive droughts even for long periods, because of the ability to transform their stored fat into water (Jackson, 1997). The same happens with food, since they are able to survive for very long periods with little food (Merlen, 1999).

Otoy (*Xanthosoma sagitifolium)* is known in several ways in the world, among which we mention: Spanish: yautía, malanga (Antilles), macal (Yucatán - Mexico), quiscamote (Honduras), tiquisque (Costa Rica), otó (Panama), okumo (Venezuela), uncucha (Peru), gualuza (Bolivia), malangay (Colombia); Portuguese: taioba, mangareto, mangarito, mangarás (Brazil); French: chou caribe (Antilles); English: tania, tania; Yautia New, cocoyamtanier; other languages queiquexque (Mexico), tanniataniera (Antilles) (FAO, 1992). In the breeding center of Isabela Island, tortoises are usually fed only with otoy, yautía or malanga (*Xanthosoma sagittifolium*) (unpublished data), so it is very important to know the appropriate amount of it as a diet of growth, to be consumed by juvenile tortoises reared in captivity at the "Centro de Crianza de Puerto Villamil", in order to satisfy their consumption needs and therefore not waste or exaggerate in the amount of otoy or other diets administered; with the purpose of satisfying their consumption needs and therefore not to waste or exaggerate the amount of otoy or other diets administered. The present study aims to determine the consumption capacity of otoy (*Xanthosoma sagitifolium*) in juvenile tortoises reared in captivity on Isabela Island - Galapagos, Ecuador.

MATERIALS AND METHODS

The research was carried out at the Arnaldo Tupiza Giant Tortoise Breeding Center in Puerto Villamil on Isabela Island, which is located in Latitude South: 00°94.6'84.7 and latitude west: 90°97'37.9, Galapagos – Ecuador.

Field materials: Juvenile giant tortoises (*Chelonoidis guntheri* and *Chelonoidis vicina*), belonging to the Isabela Island and born in captivity in the breeding center, also used materials for measurement and weighing, as well as otoy (*Xanthosoma sagittifolium*) as a single food.

Group 1: Conformation of 20 juvenile tortoises, aged 3 to 5 years, from the population of San Pedro (*Chelonoidis guntheri*) belonging to Isabela Island, born in captivity at the Breeding Center of Isabela (Figure 1 - right). The group was housed in a barnyard of 280 cm long by 240 cm wide, with soil floor and at an altitude of 80 cm from the ground. It has a water well of approximately 80 cm in diameter. The sum of weights of all tortoises at the beginning of the investigation was 29.55 kg, with an average of 1,477 kg per tortoise. It has a water well approximately 80 cm in diameter. The sum of weights of all tortoises at the beginning of the investigation was 29.55 kg, with an average of 1,477 kg per tortoise. The feed was administered in the soil of the corral in proportions of 1, 2, 3 and 4 kg of otoy throughout the investigation, until consumption was standardized in 2.5 kg of otoy throughout the corral.

Group 2: Conformation of 20 juvenile tortoises, between 3 and 4 years, of which 17 belong to the population of Cazuela and 3 to the population of San Pedro, both subpopulations (*Chelonoidis guntheri*) of Isabela Island (Figure 1 - Center). They were housed in a corral of 460 cm long by 130 cm wide, with earth floor and at an altitude of 80 cm from the ground. The corral has a cement canoe-shaped feeder of 370 cm long by 23 cm wide and a depth of approximately 5 cm; also has water well of 90 cm in diameter. The sum of the weight of all the tortoises was 30.7 kg, with an average of 1,535 kg per tortoise. The feed was provided exclusively in the feeder between 1, 2, 3 and 4 kg of otoy during the whole investigation, until standardizing the consumption in 2.5 kg of otoy throughout the corral.

Group 3: With 20 juvenile tortoises, between 2 and 4 years, of which 19 belong to the population of Cinco Cerros (*Chelonoidis vicina*) and 1 to the population of Roca Unión (*Chelonoidis guntheri*), belonging to Isabela Island (Figure 1 - left). The animals were housed in a corral 460 cm long by 130 cm wide, with soil floor and at an altitude of 80 cm from the ground. The corral has a cement canoe-shaped feeder of 370 cm long by 23 cm wide and a depth of approximately 5 cm; also has a water well 90 cm in diameter. The sum of the weight of all tortoises was 27.94 kg, with an average of 1.4 kg per tortoise. Food was provided only in the feeder and 1, 2, 3 and 4 kg of otoy were administered during the whole investigation, until standardized consumption in 2.5 kg of otoy throughout the corral.

Group 4: With 30 juvenile tortoises, belong to the population of Roca Unión (*Chelonoidis guntheri*), between 1 and 2 years, belonging to Isabela Island (Figure 2 - Right).

Figure 1. Giant tortoises of groups 1, 2 and 3

Right: Group 1; Center: Group 2; Left: Group 3

The animals were housed in a corral 280 cm long by 240 cm wide, with soil floor and at an altitude of 80 cm from the ground. It has a water well of approximately 80 cm in diameter. The sum of weights of all tortoises at the beginning of the investigation was 5.25 kg, with an average of 174.83 grams per tortoise. The feed was administered in the soil of the corral at a rate of 0.2, 0.4, 0.6, 1 and 1.5 kg of otoy during the whole investigation, until standardizing the consumption in 0.4 kg of otoy throughout the corral.

Group 5: With 43 juvenile tortoises from the population of Cinco Cerros (*Chelonoidis vicina*) of Isabela Island, with age between 1 and 2 years (Figure 2 - left). The group was housed in a corral of 280 cm long by 240 cm wide, with soil floor and at an altitude of 80 cm from the ground. It has a water well of approximately 80 cm in diameter. The sum of weights of all the tortoises at the beginning of the investigation was of 18.82 kg, with an average of 437.67 grams per tortoise. The feed was administered in the soil of the corral between 0.5, 0.8, 1, 1.5 and 2 kg of otoy during the whole investigation, until standardizing the consumption in 1.4 kg of otoy throughout the corral.

Figure 2: Giant group 4 and 5 tortoises

Right: Group 4; Left: Group 5

Data collection

The present study was carried out in 5 barnyards of juvenile giant tortoises, between 1 and 4 years of age. As a first action was carried out the measurement and weighing of chelonians.
The food was provided on the ground floor or in the cement trough (depending on each farmyard), chopped into small pieces, is approximately 1/3 of the leaves and 2/3 of the stem, except for the baby tortoises Group 4 in which only otoy leaves were administered. Each group was provided otoy on Mondays, Wednesdays, and Fridays, for a period of 3 months. Food administration was performed at 8:00 AM and consumption observations were made at 10:00 AM, 12:00 PM and 2:00 PM. The data obtained were used to determine the consumption of each group under study, based on the comparison of the food provided and the leftover food. The results were based on the amount of leftover food vs. the food provided. The food ingested corresponds to the consumption capacity, which was verified as the investigation went on, and later with the rationing to the rest of barnyard.

RESULTS

At the end of the investigation, there was no mortality in any of the treatments. According to the results of this study, the consumption capacity of groups 1, 2 and 3 is almost the same, that is to say 2.5 kg of otoy (for all the animals of barnyard), in a proportion of 1/3 of leaves and 2/3 of stems. With this quantity, it was possible to verify that the tortoises consume 99 to 100% of the food and at the end of the day they appear to be satisfied. The consumption capacity of group 4 and 5 was 0.4 and 1.4 kg of otoy, respectively. It is also the amount in which the tortoises consume 99 to 100% of the food and at the end of the day they are satisfied.

Table 1. Average of the consumption capacity of the groups studied

CAPACITY OF CONSUMPTION	
Group	Quantity
Group 1	89,5 g / kg body weight
Group 2	81,4 g/ kg body weight
Group 3	84,6 g/ kg body weight
Group 4	76,3 g/ kg body weight
Group 5	90,3 g/ kg body weight

In the case of groups 1, 2 and 3, the consumption capacity corresponds to an average of 89.5 g, 81.4 g and 84.6 g of otoy per kg of body weight, respectively (Table 1). In groups 4 and 5, the consumption capacity corresponds to 76.3 and 90.3 grams of otoy, per kg of body weight, respectively (Table 1).
On average, 75 to 90 grams of otoy (*Xanthosoma sagittifolium*) should be administered for each kg of body weight of juvenile tortoises reared in captivity at the Foster Center in Puerto Villamil. It was also observed that in youth group whose barnyard have a canoe-shaped cement trough, the food can be administered in small pieces of a size of approximately 6 x 6 cm, to facilitate their consumption and avoid fights. In barnyards where food is provided on the floor or on a cement platform, it should be given with the leaves and the entire stem, to avoid further contamination of the same. In baby tortoises only otoy leaves should be given, because the size of their mouth (beak) cannot consume stems and that becomes a waste of food and a smaller amount of food is ingested by such tortoises.

It was also observed that it is better to provide the feed in cement feeders in the form of a canoe, because there is little contamination of the food and therefore an increase its consumption. Although it is necessary to indicate that an advantage of feeding on the floor is that the animals compete for the food, which would be favorable because when they are repatriated they will have the instinct to strive to obtain food. In addition to the beginning of the experiment it was noticed that the tortoises of group 2 did not get used to their trough in the form of canoe, but with the passage of the days they gradually adapted and even managed to settle neatly along the same.

It is important to keep in mind that it is necessary to carry out the weighing of the tortoises every quarter, in order to increase the amount of food required by each of the animal pens.

DISCUSSION

The Galapagos archipelago, located in the Western Pacific 1000 km west of the coast of mainland Ecuador, is made up of 7 major islands, 14 smaller islands, 12 additional islands, 64 islets and 136 rocks, all of volcanic origin with about 4 million years (Ecuador, 2017). This archipelago has a unique flora and fauna in the world, with 560 species of native plants (180 of which are endemic), 17 species of mammals, 152 birds, 22 reptiles and around 2000 invertebrate species (Ecuador, 2017), within which the giant tortoises of Galapagos constitute their emblem (Poulakakis *et al*., 2015). Galapagos giant tortoises that live in arid and dry areas are known to feed mainly on fruits and cladodes of Opuntia cactus (*Opuntia echios*), as well as other available plants; the ones that live in the mountains (where there is more vegetation available) and a variety of foods, among which we can mention herbs and a number of leafy plants (Merlen, 1999).

In this research was used Otoy, yautía or malanga (*Xanthosoma sagittifolium*) in the feeding of juvenile chelonians. The Otoy is a plant that grows along the American continent and whose origin is possibly in the northern part of South America and spread through the Antilles and Mesoamerica (FAO, 1992); tortoises do not consume this food in the wild, but eat in captivity (Márquez *et al*., 1999), for that reason it is very important to determine the amount of otoy necessary to maintain adequate growth of the tortoises in the breeding centers avoiding food waste and at the same time improving the animal health of animals. To the knowledge of the authors there are no reports related to the determination of the consumption capacity of Otoy (*Xanthosoma sagittifolium*) in juvenile tortoises of Galapagos, so this is considered the first report of the same. As observed in the present study, administering between 75-90 grams of otoy per kilogram of body weight could keep animals healthy and able to continue their daily lives.

In the breeding center of the Isabela Island there are breeding programs of the Galapagos where the care of the animals is optimized from the incubation of the eggs, hatching, growth, and release of the animals to their natural habitat; the diet offered in the facilities of the center basically consists of the administration of Otoy (*Xanthosoma sagittifolium*), ad libitum, where much waste and contamination of the food with the excretions of the chelonians is observed. This study indicates that administration of 75-90 grams of Otoy (*Xanthosoma sagittifolium*) per kilogram of body weight may be enough to keep the animals satiated and the right amount of nutrients for their development and growth. Other studies recommend to administer 800 grams/day of food, to provide approximately 4401.0 kcal, in order to optimize the maintenance of the chelonians in captivity; however, this recommendation is for adult giant Galapagos tortoises of the Zoo of Guayllabamba of Quito, indicated by Ortega (2002), which differs from the amount of food determined in this study. What is known in Galapagos juvenile tortoises is that low levels of protein (10-15%) and high levels of crude fiber (30-40%) should be provided in order to promote reduced digestibility (Furrer S, Hatt Jean, Snell H, Márquez Cruz, Honnegger R, 2004).

Also, a higher concentration of calcium increases the digestibility of calcium, phosphorus and magnesium (Liesegang *et al*., 2001). It is also recommended not offer papaya (*Carica papaya*) to juvenile tortoises, since it can produce indigestion, and depending on the severity, even causing death (Márquez *et al*., 1999). The otoy, yautía or malanga, is a perennial herbaceous, composed by an underground main stem, from which secondary stems emerge; from the main stem leaves large, sagittal and erect leaves; is traditionally a subsistence crop with family consumption, and although it is the staple food of millions of people, especially in tropical regions, little information is available on its crop, requirements and nutritional aspects (FAO, 1992). Tagodoe and Nip (1994) described by Owusu-Darko *et al*. (2014) concluded that otoy flour is rich in starch and total dietary fiber and low in fat, protein and ash, finding a humidity of 69.1%, fat 0.10%, carbohydrates 1.01%, ash 0.97% ; has higher protein content than most other tropical roots, indicating that lysine is the first limiting amino acid.

Studies in leatherback tortoises (*Dermochelys coriacea*) indicate that they eat large amounts of food, between 50% and 73% of body mass, but have been criticized as too high; these tortoises have rapid digestion and shorter intestinal transit times (Davenport, 2017) compared to Galapagos giant tortoises, which have a slow intestinal transit of 1 to 3 weeks (Jackson, 1997; Liesegang *et al*., 2001), although the retention time is variable among Galapagos tortoises, depending on the food, season of the year, ambient temperature, etc.; (Sadeghayobi *et al*., 2011), even large numbers of the plants that eat the terrestrial tortoises are easily identified in their fecal matter, and the average retention time varies from 6 to 28 days, with an average of 12 days, Even large numbers of plants that eat terrestrial tortoises are easily identified in their faecal matter, since they do not fully digest the food consumed (Jackson, 1997).

In studies on juvenile green tortoises (*Chelonia mydas*), fed ad libitum with 1, 2, 3 and 4 meals daily (4 treatment groups), it was shown that there was no mortality in any of the treatments and the weight and height gain was ($P > 0.05$), differing from group 1 ($p < 0.05$), in which an excessive dietary intake was evidenced; in addition, it has been shown that the feeding of juvenile green tortoises twice a day would be the correct form, promoting growth, reducing feed consumption and improving health and quality of the shell (Kanghae *et al*., 2016). More studies need to be carried out on the nutrition of these chelonians, unique in the world, in order to offer an adequate quality of life to the animals, avoiding nutritional problems and promoting an adequate growth, ensuring that the animals reach sexual maturity and reproduce properly when introduced to their environment.

Conclusion

With the above, it can be concluded that the capacity of consumption of otoy (*Xanthosoma sagittifolium*) in juvenile tortoises bred in captivity in the Tortoise Breeding Center of Puerto Villamil, is of 75 to 90 grams by each kg of body weight, being recommended to use the amount of 80 grams/ kg of body weight. This data can be used as amount of otoy necessary as a growth diet in this center and can serve as a basis for further studies.

REFERENCES

Beynon, P., & Cooper, J. 1999. *Manual of exotic pets*. (B. S. A. veterinary A. (BSAVA), Ed.) (Primera). Gloucestershire-United Kingdom.

Carrillo, E., Aldás, S., Altamirano, M., Ayala, F., Cisneros, D., Endara, A., … Zarate, P. 2005. *Lista roja de los Reptiles del Ecuador*. (Serie Proyecto PEEPE, Ed.). Quito-Ecuador: Fundación Novun Milenium. Retrieved from http://suia.ambiente.gob.ec/documents/10179/346522/Lista+de+reptiles+del+Ecuador.pdf/55ae5322-12b0-4300-a221-c95435abb888

Davenport, J. 2017. Crying a river: how much salt-laden jelly can a leatherback turtle really eat? *Journal of Experimental Biology*, *220*. http://doi.org/doi: 10.1242/jeb.155150

Ecuador, M. del A. del. 2017. Parque Nacional Galápagos. Retrieved from http://www.ambiente.gob.ec/parque-nacional-galapagos/

FAO, F. A. O. 1992. *Cultivos marginados - otra prespectiva de 1492*. *Coleccion FAO: Producción y protección vegetal Nro. 26*.

Froyd, C. a., Coffey, E. E. D., van der Knaap, W. O., van Leeuwen, J. F. N., Tye, A., & Willis, K. J. 2014. The ecological consequences of megafaunal loss: Giant tortoises and wetland biodiversity. *Ecology Letters*, *17*(2), 144–154. http://doi.org/10.1111/ele.12203

Furrer S, Hatt Jean, Snell H, Márquez Cruz, Honnegger R, R. A. 2004. Comparative study on the grown of juvenile Galapagos giant tortoises (Geochelone nigra) at the Charles Darwin Research Station (Galapagos Island, Ecuador) and Zoo Zurich (Zurich Switzerland). *Zoo Biology*, *23(2)*, 177–183. http://doi.org/10.1002/zoo.10130

Hunter, E., Gibbs, J., Cayot, L., & Tapia, W. 2013. Equivalency of Galápagos Giant Tortoises Used as Ecological Replacement Species to Restore Ecosystem Functions. *Conservation Biology*, *701*(9). http://doi.org/10.1111/cobi.12038

IUCN, I. U. for C. of N. 2016. The IUCN Red List of Threatened Species. http://doi.org/ttp://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T9028A97238881.en

Jackson, M. 1997. *Galápagos: A Natural History Guide*. (T. U. of Calargy, Ed.) (Second). Canadá.

Jaffe, A. L., Slater, G. J., & Alfaro, M. E. 2011. The evolution of island gigantism and body size variation in tortoises and turtles. *Biology Letters*, *7*(January), 558–561. http://doi.org/10.1098/rsbl.2010.1084

Kanghae, H., Thongprajukaew, K., Yeetam, P., Jarit-ngam, T., Hwan-air, W., Rueangjeen, S., & Kittiwattanawong, K. 2016. Optimal feeding frequency of captive head-started green turtles (Chelonia mydas). *Journal of Animal Physiology and Animal Nutrition*, *100*(5). http://doi.org/10.1111/jpn.12583

Kirkwood, R., Rodríguez, D., Rengifo, J. M., & Nassar, F. 1999. Nutrición en Fauna Silvestre. In *Seminario del Centro de Primatología Aracuatos* (p. 90). Bogotá-Colombia.

Liesegang, A., Hatt, J.-M., Nijboer, J., Forrer, R., Wanner, M., & Isenbügel, E. (2001). Influence of different dietary calcium levels on the digestibility of Ca, Mg, and P in captive-born juvenile Galapagos giant tortoises (Geochelone nigra). *Zoo Biology*, *20*, 367–374. http://doi.org/10.1002/zoo.1035

Márquez, C., Cayot, L., & Rea, S. 1999. *La crianza de tortugas gigantes en cautiverio*. (A. E. F. C. Darwin, Ed.) (Primera). Puerto Ayora.

Merlen, G. 1999. *El reino del galápago volviendo a su edad de oro*. (F. C. Darwin, Ed.) (Primera). Puerto Ayora.

Milinkovitch, M. C., Monteyne, D., Gibbs, J. P., Fritts, T. H., Tapia, W., Snell, H. L., … Powell, J. R. 2004. Genetic analysis of a successful repatriation pagos tortoises programme : giant Gala. *Proceedings: Biological Sciences*, *271*(October 2003), 341–345. http://doi.org/10.1098/rspb.2003.2607

Ortega, A. 2002. *Plan para la implementación de un sistema de alimentación para los animales del Zoológico de Quito en Guayllabamba*. Universidad Central del Ecuador.

Owusu-Darko, P. G., Paterson, A., & Omenyo, E. L. 2014. Cocoyam (corms and cormels) — An underexploited food and feed resource. *Journal of Agricultural Chemistry and Environment*, *3*(1), 22–29. http://doi.org/http://dx.doi.org/10.4236/jacen.2014.31004

Parham, J. F. 2008. Rediscovery of an “extinct” Galápagos tortoise. *PNAS*, *105*(40), 15227–15228. http://doi.org/www.pnas.org/cgi/doi/10.1073/pnas.0808013105

Poulakakis, N., Edwards, D. L., Chiari, Y., & Garrick, R. C. 2015. Description of a New Galapagos Giant Tortoise Species (Chelonoidis ; Testudines : Testudinidae) from Cerro Fatal on Santa Cruz Island. *Plos One*, *10*(10). http://doi.org/10.1371/journal.pone.0138779

Sadeghayobi, E., Blake, S., Wikelski, M., Gibbs, J., Mackie, R., & Cabrera, F. 2011. Comparative Biochemistry and Physiology , Part A Digesta retention time in the Galápagos tortoise (Chelonoidis nigra). *Comparative Biochemistry and Physiology, Part A*, *160*(4), 493–497. http://doi.org/10.1016/j.cbpa.2011.08.008

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