Assessing rehydration protocols on dried sea cucumber *Holothuria arguinensis*

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Abstract

Sea cucumbers have been traditionally consumed as a tonic food in Asia for thousands of years; between 80% and 90% of sea cucumbers are dried to prevent their autolysis and to facilitate their storage, exportation and sale. Although in recent years, an increase of fresh and frozen sea cucumber products has been observed in the Asiatic markets.

Scarce information about rehydration protocols has been published on sea cucumbers until now. *Holothuria arguinensis* is one of the new target species caught from NE Atlantic. In this paper, its rehydration ratio (Rr) is assessed using two different protocols and compared with ratios obtained with other commercial species such as *Holothuria scabra* and *Apostichopus japonicus*. The highest value of rehydration rate on *H. arguinensis* (Rr = 3.78) was relatively close to the value registered for *Apostichopus japonicus* (Rr = 4.07) by other authors, and higher than the value obtained for *H. scabra* (Rr = 3.05). The obtained results are very valuable to improve the rehydration protocols used on *H. arguinensis*, allowing the maximum recovery rates of weight and length from the dried product.

Introduction

Holothuria (Roweothuria) arguinensis Koehler and Vaney, 1906, is being considered as a target species in the expanding sea cucumber fishery (González-Wangüemert et al. 2016, 2018). This species had been considered to be a north-eastern Atlantic species that is distributed from Portugal to Morocco and Mauritania, including the Canary Islands (González-Wangüemert and Borrero-Pérez 2012). It has not been found in other Macaronesian Islands such as Açores, Selvagens or Madeira, or in the Cape Verde Archipelago (Pereira 1997; Borerro-Pérez et al. 2010; Micael et al. 2012). However, its geographical distribution is changing, and includes the colonisation of the Mediterranean Sea (González-Wangüemert and Borrero-Pérez 2012; Mezali and Thadar 2014).

Sea cucumbers have been traditionally consumed as a tonic food in Asia and the Middle East for thousands of years (Zhang et al. 2016); they contain certain nutrients, which are beneficial to health. In the case of *H. arguinensis* high levels of protein were found and its lipid profile was rich in polyunsaturated fatty acids (PUFA) (Rogattz et al. 2016).

In recent years, sea cucumber consumption has been increasing in the Asian region with fisheries focusing on exportation of products in at least 70 countries (Purcell et al. 2012). More than 66 species are being fished, their dried product (the beche-de-mer) reaching prices up to USD 500 kg^{-1} (Purcell et al. 2013). Sea cucumber-derived food products, including instant sea cucumber, sea cucumber capsules and sea cucumber caplets, can be found on the market (Zhang et al. 2016).

Usually, fresh sea cucumbers autolysis occurs rapidly after being harvested, due to the presence of autolytic enzymes in their body. Therefore, between 80% and 90% of sea cucumbers are dried to prevent autolysis and to facilitate their storage, exportation and sale (Aydin 2008; Zhang et al. 2016; González-Wangüemert et al. 2018). Although in recent years, an increase of fresh and frozen sea cucumber products has been observed in Asian markets (Purcell et al. 2014; Sze and Conand 2015).

Rehydration of dehydrated food is a complex phenomenon that is affected by numerous factors including medium characteristics, pre-soaking time, number of rehydration times, size of the food sample, and drying method (Geng et al. 2015). Most of the rehydration protocols of dried sea cucumbers are done in cold, clean water for 2–3 days before further processing or cooking (Duan et al. 2008).

The published information about sea cucumber rehydration process is scarce (Fukunaga et al. 2004; Liu and Ko 2002; Xiang et al. 2007). Hong et al. (2014)

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who worked with different rehydration methods on hot air-dried sea cucumber, found a rehydration ratio ranging from 5 to 6 for *Apostichopus japonicus*. Zhang et al. (2016) used ultrasound-assisted rehydration and obtained rates ranging from 2.71 to 4.35 for the same species. No information on the rehydration of *H. arguinensis*, a newly targeted species from the Mediterranean and NE Atlantic, has been published. Therefore, our objective has been to assess the rehydration ratio (Rr) of *H. arguinensis* using two different protocols and to compare it with ratios obtained with other commercial species, either by us (*Holothuria scabra*) or by other authors (*A. japonicus*).

Material and methods

Two methodologies for rehydration of four *H. arguinensis* specimens from Ria Formosa (Southern Portugal) were used (Figure 1): A) the dried sea cucumbers were soaked in filtered water (filter of active carbon) during 96 hours at 4ºC; the water was changed every 24 h; B) the dried sea cucumbers were submerged in filtered water during 3 hours, then boiled for 30 minutes, and finally, when the water temperature had decreased, they were conserved at 4ºC overnight; this procedure was repeated at 40 h and 96 h. The recycling of water was carried out every 24 h, during the 96 h. One individual of *H. scabra* from Australia was also rehydrated using protocol-A.

The eviscerated weight (EW ± 0.01 g) and eviscerated length (EL ± 0.1 mm) for each individual were registered along the different phases of process. Water absorption by sea cucumbers was determined after rehydration. The rehydrated sea cucumbers were blotted with absorbent paper to remove excess water from their surface. Rehydrated ratio (Rr) was calculated by the following equation: $Rr = W_f / W_0$, where W_f and W_0 are the weights of the sea cucumber before and after rehydration, respectively. Also, the patterns of change in weight (ΔW) and length (ΔL) of the individuals along the time period of rehydration (96 h) were evaluated.

Results and discussion

The second methodology of rehydration (B) was more effective than the first one (A) taking into account the Rr, and length-weight recovering rates on *H. arguinensis* (Table 1): an average Rr of 3.775, was registered; this value being higher than the one obtained for *H. scabra* (Rr = 3.05) and *H. arguinensis* under rehydration protocol-A (Rr = 2.9). The highest value (Rr = 3.78) was relatively close to the Rr registered for *A. japonicus* (Rr = 4.07), which was obtained from a traditional rehydrated protocol in high-quality individuals (Zhang et al., 2016). It is important to highlight that the methodology used to produce beche-de-mer has an influence on its porous structure and therefore on its water holding capacity, which is linked to the rehydration ratio (Chong et al. 2015).

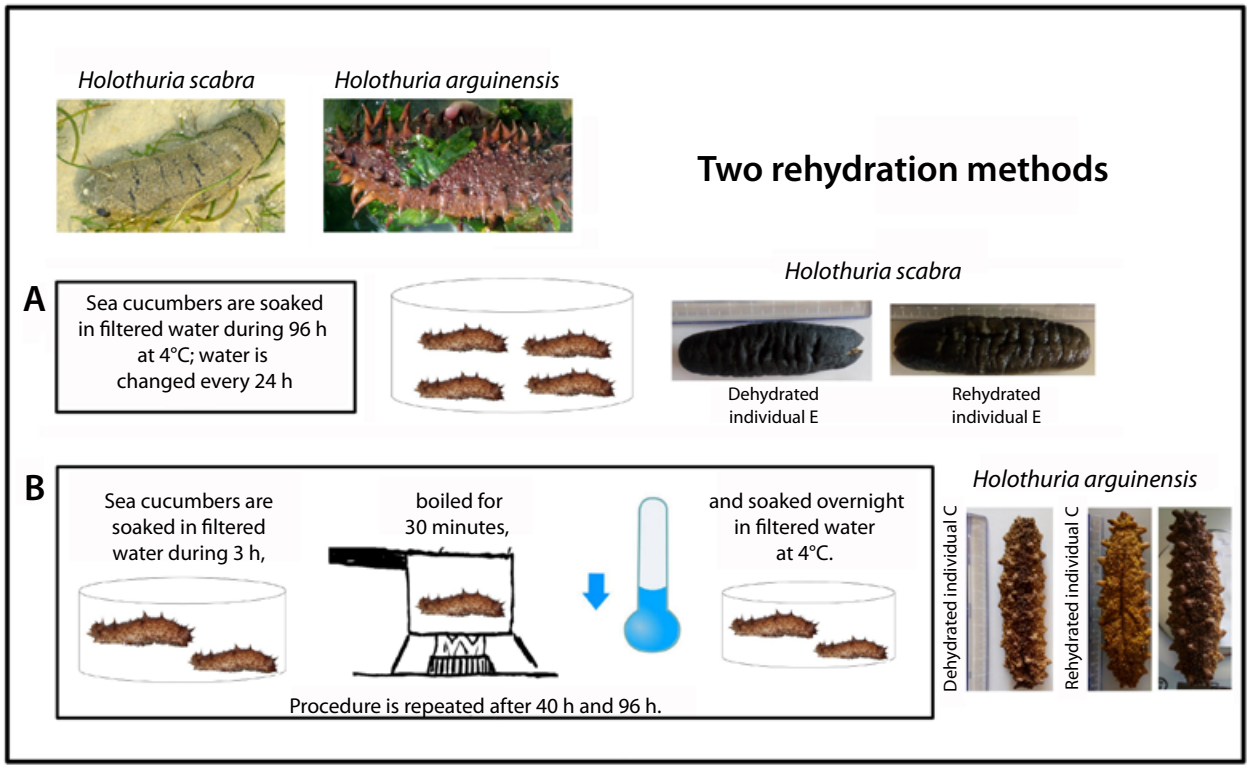

Figure 1. Rehydration protocols used on dried sea cucumbers (*Holothuria arguinensis* and *Holothuria scabra*).

Table 1. Values of length and weight increases (ΔL and ΔW) and rehydration rate (Rr) for *Holothuria arguinensis* and *Holothuria scabra* specimens. Methods 'A' and 'B' are described in Material and methods section.

Individual	Species	Method	ΔL (%)	ΔW (%)	Rr
Individual A	*H. arguinensis*	A	28.00	65.57	2.90
Individual D	*H. arguinensis*	A	32.79	66.67	3.00
Individual B	*H. arguinensis*	B	37.04	73.49	3.77
Individual C	*H. arguinensis*	B	35.53	73.47	3.78
Individual E	*H. scabra*	A	34.92	67.21	3.05

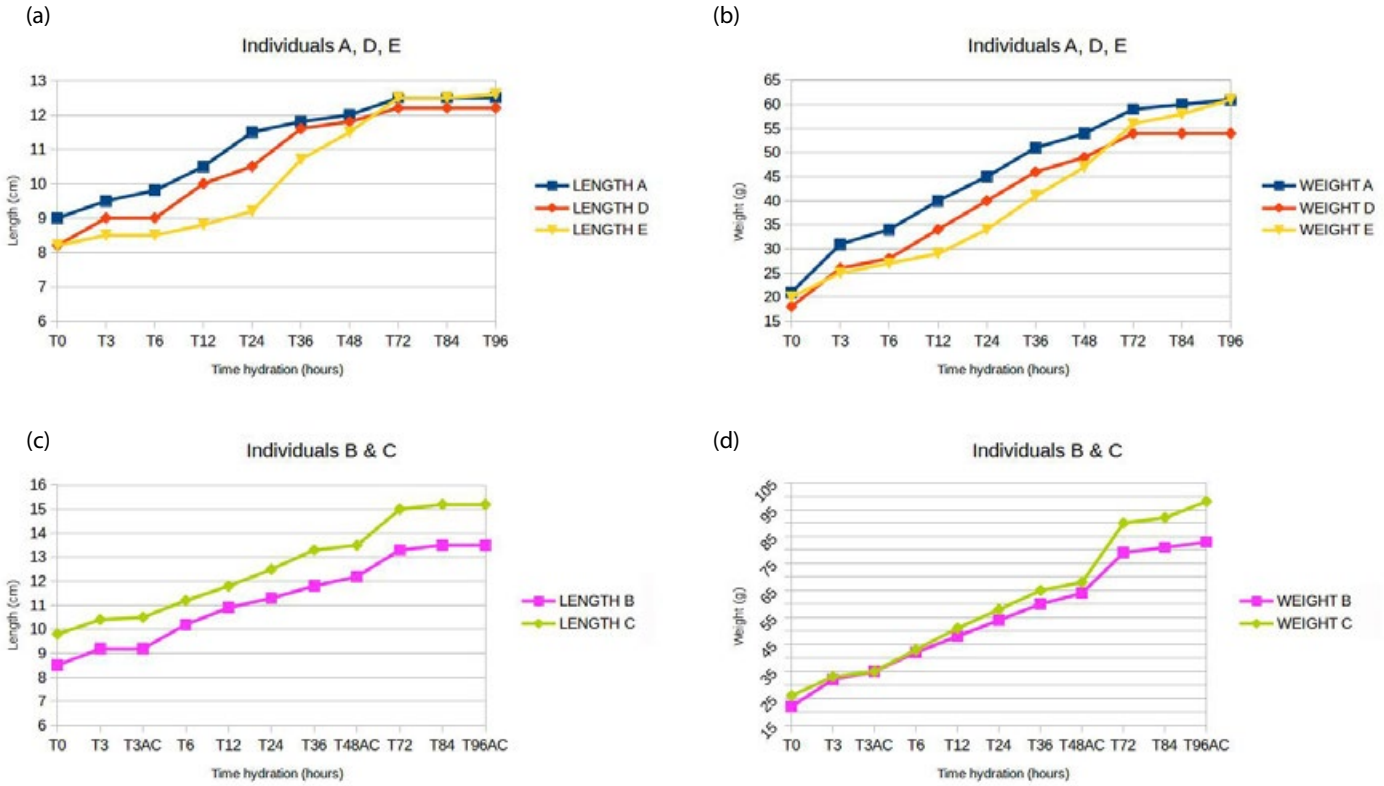

Figure 2. Length (a) and weight (b) changes along rehydration protocol-A on individuals A, D, E (*Holothuria arguinensis* and *Holothuria scabra*); Length (c) and weight (d) changes along rehydration protocol-B on individuals B and C (*Holothuria arguinensis*).

H. arguinensis, which was rehydrated according the second methodology (B) showed average recovery rates of weight and length close to 73.4% and 36.3% respectively (Table 1; Figure 2). These values were also higher than rates registered with *H. scabra* (67.2% and 34.9%) or *H. arguinensis* rehydrated using methodology A without boiling (average values: 66.1% and 30.4%) (Table 1; Figure 2).

These results are very valuable to improve the rehydration protocols used on *Holothuria arguinensis*, as they allow for the maximum recovery rates of weight and length from the dried product.

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