Should *Limnothrissa miodon* be Eaten and *Lamprichthys tanganicanus* Thrown? Proximate Analysis-based Arguments for a Lake Kivu Fish Resource Marketability

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Summary

This study provides arguments based on proximate analysis of Limnothrissa miodon *(Boulenger, 1906) and* Lamprichthys tanganicanus *(Boulenger), two introduced fishes in Lake Kivu from Lake Tanganyika to enhance consumers' attraction towards the neglected* L. tanganicanus. *The results indicated that* L. tanganicanus *and* L. miodon *have the same composition of mineral materials.* Limnothrissa miodon *was more protein- and calorie-rich than* L. tanganicanus. *The latter contained more fat. Despite these differences in macronutrient content, both* L. tanganicanus *and* L. miodon *are of high quality and accessible food resources that can contribute to food security and poverty alleviation by supplying animal proteins and other nutritional requirements to the poorest among the riparian population of Lake Kivu.*

Résumé

Limnothrissa miodon devrait-il être mangé et *Lamprichthys tanganicanus* jeté? Des arguments basés sur l'analyse immédiate pour une commercialisation des ressources halieutiques du Lac Kivu

Se basant sur les résultats de l'analyse immédiate de Limnothrissa miodon *(Boulenger, 1906) et de* Lamprichthys tanganicanus *(Boulenger), deux poissons endémiques du lac Tanganyika introduits au lac Kivu, cette étude cherche à fournir des arguments pour intéresser de plus en plus les consommateurs à valoriser le trop négligé* L. tanganicanus. *Les résultats de cette étude ont montré que* Limnotrissa miodon *était plus protéique et plus énergétique que* L. tanganicanus *alors que ce dernier était plus gras. La composition en matière minérale était identique entre les deux espèces. Cependant, malgré ces différences entre les valeurs nutritionnelles,* L. miodon *et* L. tanganicanus *sont tous deux d'une grande valeur nutritive et constituent d'importantes ressources alimentaires pouvant contribuer à la réduction de la pauvreté et à la sécurité alimentaire en fournissant des protéines animales et autres éléments nutritifs requis aux populations démunies parmi les communautés riveraines du lac Kivu.*

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Introduction

Lake Kivu, one of the large lakes of the East-African rift, has a very poor fish fauna compared to other lakes in the region: only 29 species among which six were introduced (26). The most famous is the Tanganyika sardine *Limnothrissa miodon* introduced to Lake Kivu during the end of 50s (7). Its presence and growth permitted the development of an important fishery (34) and the reduction of protein-calorific borne malnutrition among the riparian communities (20, 23).

Despite the importance of the Tanganyika sardine as a nutritious food to the populations around this lake, little is known about its proximate composition, which would allow providing nutritional information (1, 32, 33) necessary for their maximum utilization (1). Only fatty acid profiles were recently established for these two fishes (24) but further information is still needed. In addition, human mortality due to malnutrition remains high, hovering around 10% in this area (28) and the prevalence of protein-calorific malnutrition is evaluated about 5% in the town of Bukavu (10). In this context, each resource easily accessible and nutritious should be sustainably exploited. Furthermore feeding habit reluctance against available resources should be minimized. *Lamprichthys tanganicanus*, Poecilidae recently introduced in Lake Kivu (26, 27), has become spread and present in all fish catches from Lake Kivu. It constitutes together with *L. miodon* a good source of ω3 fatty acids (24) which are known to be for the most part responsible of nutritional value of foodstuffs (4, 6, 36) and to prevent cardiovascular diseases (21). Unfortunately, despite its affordable cost (1.5 USD/kg) compared to that of imported fishes (~8 USD/kg) and even that of *L. miodon* (4 USD/kg), since 2006 when it appeared in Lake Kivu (26, 27), the riparian populations showed a reluctance regarding its consumption. The reluctance is comparable to that observed in Poland towards fishes raised in Poland compared with those imported from China despite the very low nutritional quality of the imported ones (36). *L. miodon* is widely preferred than *L. tanganicanus*.

The aim of this study is to compare the proximate composition of *L. miodon* and *L. tanganicanus.* The results of this comparison would allow the vulgarisation of this food item as an incentive for its consumption and marketability of the neglected.

Material and methods

Biology of the fishes studied

Limnothrissa miodon is morphologically easily distinguished from *L. tanganicanus* (Figure 1). Even if the mean size of these two species is in the same range at adult stage (total length ~ 85 cm) (24), *L. tanganicanus* has generally conspicuous coloration (olive greenish more or less darkened) with a series of blue spots at all sides of the lateral line (Figure 1) while *L. miodon* is recognized by a glittering aspect with silvery scales which stand out at any slightest touch. Concerning their ecology, *L. tanganicanus* lives mainly in the rocky shores and in pelagic area in the absence of predators (26) while *L. miodon* lives mainly in pelagic area (38) and only comes to the shorelines for breeding. These two species have almost the same diet (26) suggesting a high likelihood of interspecific competition in the conditions where available resources are limited.

Sampling

Fish samples analyzed in this study were collected using a 10 mm mesh-size fish net (length: 200 m; height: 9 m) in the Congolese side of Lake Kivu, Bukavu Bay (Nyalukemba-Muhumba) (Figure 2). They consisted of 36 specimens of *L. miodon* and *L. tanganicanus* adults of almost same size. In the field, immediately after fishing, they were sorted out by species thanks to their remarkable morphological patterns and measured (to nearest 1 mm length) the total length (TL) using a graduated board.

Fishes were dissected and their gut contents removed. Then the fish samples without gut contents were frozen.

Figure 1: Pictures of *L. tanganicanus* (a) and *L. miodon* (b) of Lake Kivu.

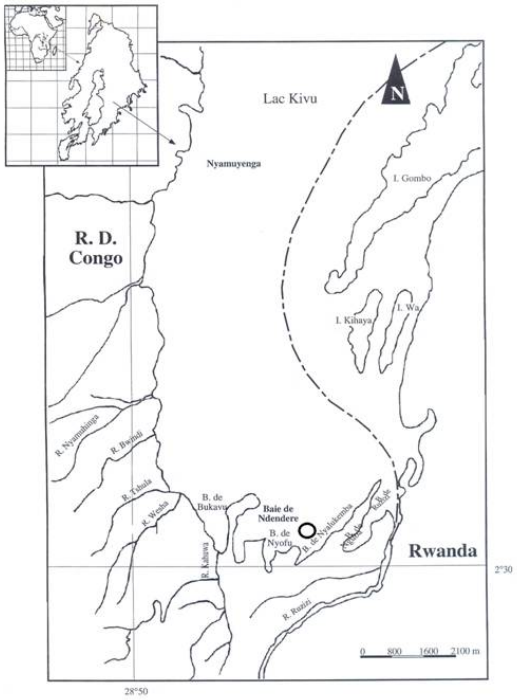

Figure 2: Sampling site (Bukavu bay, Nyalukemba-Muhumba).

Sample treatment and proximate composition determination

In the laboratory of the "Office Congolais de Contrôle" (OCC), all frozen samples were thawed and oven-dried at 105 °C to constant weight (3). The dry samples allowed estimating the moisture content (%). These dry samples were ground to fine powder using a metallic mortar and pestle for further analyses. For each species, all powder samples were pooled together and homogenized. Samples for the different chemical analyses were then taken from the homogenized material. Triplicate determinations were carried out on each sample.

Proximate composition of the following nutrients was determined using standard procedures (3): crude ash content (%) determined by incineration of the dried sample in a muffle furnace at 800 °C for 2 h, crude protein content (%) calculated by converting the nitrogen content determined by Kjeldahl's method (= 6.25 x N) and crude fat content (%) determined after the Soxhlet extraction with toluene.

Table 1

Mean proximate composition.

Component (% or mg/100 g)	*Limnothrissa miodon*	*Lamprichthys tanganicanus*
Moisture	70.6 ± 2.1[a]	70.6 ± 1.7[a]
Ash	11.9 ± 0.5[a]	14.0 ± 2.4[a]
Protein	50.6 ± 3.6[a]	40.4 ± 3.8[b]
Lipid	18.1 ± 0.2[a]	21.9 ± 1.9[b]
Energy content (kcal/100g)	359.6	375.0
Fatty acids groups (*)		
Total SAFA	43.5 ± 8.2	41.5 ± 7.6
Total MUFA	14.0 ± 3.9	17.8 ± 3.9
Total PUFA	42.4 ± 9.1	40.5 ± 9.1
Total ω3	33.5 ± 8.5	33.9 ± 9.0
Total ω6	8.9 ± 2.1	6.5 ± 1.7

(mean value ± SD), energy value (kcal/100 g) and total fatty acids groups (mean value ± SD) of *L. miodon* and *L. tanganicanus* of Lake Kivu (For each component, the different superscripts suggest the difference of the means is significant at the 0.05 statistical level).

(*) Results from Masilya (2011a)

SAFA: Saturated fatty acids, MUFA: Monounsaturated fatty acids, PUFA: Polyunsaturated fatty acids

The mean values of total proteins and total lipids were used to calculate the energy values of the two fish species. The calculations were made with the following energy equivalents: 4 kcal/g or 17 kJ/g for proteins and 9 kcal/g or 38 kJ/g for lipids (36).

Statistical analysis

Student t-test analysis was applied to determine differences between the mean values of different nutrients measured in the two fish species. All statistical tests were carried out under the R environment (R Development Core Team 2005).

Results

The different crude nutrient contents analysed vary from one species to the other as indicated by the proximate composition analysis (Table 1). Thus, the concentration of ash (11.9% vs 14.0%) (Student t-test, p=0.144) and moisture (70.6% vs 70.6%) (Student t-test, p=0.983) of these two species were comparable. However protein (50.6% vs 40.4%) (Student t-test, p=0.025) and lipid (18.1% vs 21.9%) (Student t-test, p=0.023) contents differed substantially. In other words, our findings (Table 1) indicate that *L. miodon* contains more protein and more calories (359.6 kcal) than *L. tanganicanus* (375.0 kcal). The latter one contained more fat than the first one.

Discussion

The present study compares the proximate composition of *Limothrissa miodon* and *Lamprichthys tanganicanus*, two fish resources on which the fisheries industry is currently relying. Both species represent 5,000 to 6,000 metric tons of fish stocks (16), either an economical potential of 20 to 24 million US dollars *per annum*. The result of crude protein content reveals the potential of these two fish species to be used to fight malnutrition diseases. Indeed, although having a low percentage of crude protein compared to that of *L. miodon,* the content of *L. tanganicanus* remains far higher than that measured on some species like *Oreochromis niloticus* (13, 31, 36), *Clarias gariepinus* (12, 32, 33), appreciably consumed in other African countries and found also in Lake Kivu or other marketed fishes in its surrounding towns such as *Lates niloticus* (11, 19) and *Chrysichtys nigrodigitatus* (30).

Nevertheless local communities do not like eating *L. tanganicanus* probably because it is still recent within the lake, new in their feeding habits and also because of wariness caused by a non-recognized origin by the consumers. However it is known that a larger number of consumers do eat fish because of its availability, flavours and palatability but not necessarily due to its nutritional value which most of the time is not known traditionally (13, 36).

According to Comelade (8) and Usydus *et al.* (35), fatty fishes are those which experience a crude lipid content situated between 10 and 20%. Therefore based on this classification, both *L. miodon* and *L. tanganicanus* can be classified as fatty fishes. The higher fatty content in these two fish species and their higher percentage of PUFA (*L. tanganicanus* vs. *L. miodon*: 40.5 vs 42.4%), especially the percentage of the ω-3 fatty acids (33.9 % vs 33.5 %, Table 1; 23), indicated a high nutritional value (18, 36). So, their regular consumption can prevent coronary and cardiovascular diseases (21, 36) and may also lead to an improvement in learning ability (14, 15, 22, 37). However, the high crude lipid content of *L. tanganicanus* compared to that of *L. miodon* exposes *L. tanganicanus* to a faster degradation due to its high lipid composition (17) and would explain the complaints of the fishermen that they do not like to capture *L. tanganicanus* in their fish nets because it degrades faster. Moreover, Lake Kivu fishermen do not have access to preservation facilities: fishing activities are conducted at night and followed by product sales in the morning in poor hygiene and preservation conditions. Many other consumers do not appreciate *L. miodon* due to its skin which remains tough even though it is cooked.

The higher crude ash content obtained for the two species analysed is an indicator that they are good sources of crude minerals that contribute greatly to good health (9). However, the ash values obtained are very high compared with those obtained for other types of freshwater (29, 32, 33, 36), brackish water (1) and marine fishes (29, 36). This difference would be explained by the fact that our samples were made of entire fishes (i.e., in the state that the population consumes them) including bones and scales which are known as being very rich in limestone (2, 5).

Finally, with regard to the results of this study, it may be concluded that *L. miodon* as well as *L. tanganicanus* are suitable foods for human diet. Therefore, in the context of the persistence of malnutrition and extreme poverty among the populations surrounding Lake Kivu, it is necessary to incorporate *L. tanganicanus* into the dietary habits of the populations as an important nutritional resource, especially because it becomes more and more abundant in the lake fish stock.

Knowing that it is not easy to bend the course of people's food preference, different approaches (socio-economic and food biotechnological) are needed for the product advertise and marketing, in order to ensure *L. tanganicanus* is also consumed in all cities surrounding Lake Kivu. The consumption of this fish resource is also essential for the sustainability of Lake Kivu fisheries, given the reported ecological competition between *L. miodon* and *L. tanganicanus* which is characterized by diet overlap and habitat competition (25, 26).

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