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CONDITIONS OF AFRICAN SHARPTOOTH CATFISH DE-HEADING PROCESS®

Uwarunkowania operacji odgławiania suma afrykańskiego®

The work was carried out as part of the statutory research of the Faculty of Mechanical Engineering of the Koszalin University of Technology, under the project No. 524.02.2, entitled "Comprehensive management of African catfish in terms of technique and technology of innovative products, including biochemical and nutritional research"

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This article discusses aspects of the de-heading in terms of mechanical nuisance and technological and material efficiency. The specificity of the carcass structure and the skeletal system of the head and spine of the African sharptooth catfish is presented. The conditions, possibilities and limitations of African catfish de-heading are analysed due to its structure.

Key words*:* fish de-heading, African sharptooth catfish.

W artykule omówiono znaczenie operacji odgławiania ze względu na uciążliwość mechaniczną i wydajność technologiczno-materiałową. Przedstawiono specyfikę budowy tuszy i układu kostnego głowy i kręgosłupa suma afrykańskiego. Przeanalizowano uwarunkowania, możliwości i ograniczenia odgławiania suma afrykańskiego ze względu na jego budowę.

Słowa kluczowe*:* odgławianie ryby, sum afrykański.

INTRODUCTION

The African sharptooth catfish (*Clarias gariepinus)* is a fish with significant aquaculture breeding potential. In Poland, in the early 1990s, the breeding was around 60 tons per year and according to The Federation of European Aquaculture Producers (FEAP) data for 2019, the breeding level of this species of fish was around 800 tons. It ranks third in aquaculture after carp and trout. The advantageous aspect compared to carp is that African catfish breeding is not seasonal, but continuous [8, 9]. African catfish meat has an attractive texture comparable to veal, does not have an intense fishy smell, and is a semi-fatty fish with a favourable lipid composition [2, 5].

Catfish is used as a raw material primarily in the gastronomy setting. In this regard, it is, for example, popularised on the website of the local fishing group [10]. Development of breeding and the increase in the potential scale of supply are limited by the possibility of sales. The products, e.g. caned food from industrial processing, appear on the retail market, but on a supply scale, it is essentially symbolic. The development of breeding requires the development of processing on a small processing scale of about 300 tons per year (approx. 1,500 kg daily). Such a scale of processing enables sales of the product for several breeders in the region. At the same time, it enables promoting products on the scale of industrial processing and using not only the main product (fillet), but also by-products of cutting up the carcass including recovery of meat from the spine, skin, roe, and liver [9].

In a mechanical pre-treatment of fish, de-heading is a process that is significant in two aspects. De-heading is cumbersome as a mechanical operation. During pre-treatment

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of the fish carcass, de-heading requires considerable physical strength. De-heading of several fish per minute is already a problem. The second aspect concerns the influence of the method of operation on the technological and material efficiency. The problem of technological and material efficiency can be demonstrated on the example of de-heading of carp, which was presented in research and publications of the team from the National Marine Fisheries Research Institute (MIR) in Gdynia and The Koszalin University of Technology (PK) [3, 4, 6, 7]. The basic de-heading cutting lines performed with machines for small-scale processing are shown in Fig. 1. The simplest in technical implementation is cutting with one knife, rectilinear, as shown in Fig. 1a. V-cut (Fig. 1b) is more advantageous in terms of technological and material efficiency, but it requires the use of two knives. The original development of the team (MIR, PK) is a fish de-heading machine for circular cutting around the gill. The difference in the technological and material efficiency in favour of the V-cut and the gill cut, in relation to the straight cut, is about 3% [3, 6, 7]. With a processing scale of 1 tonne per day, it yields about 30 kg of fish meat.

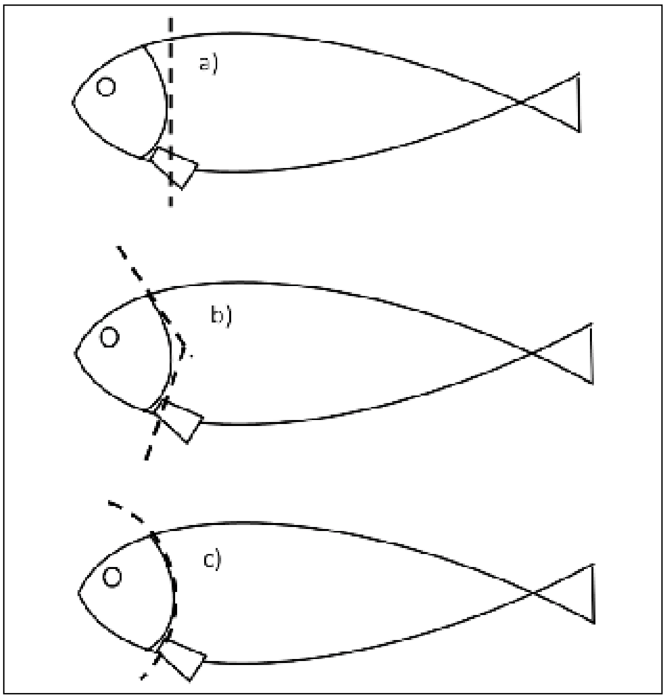

Fig. 1. Examples of de-heading cuts: a) along a straight line, b) V-cut, c) cut in the gill area.
Rys. 1. Przykłady cięć odgławiających: a) po linii prostej, b) typu V, c) okołoskrzelowe.
Source: Own study
Źródło: Opracowanie własne

Fig. 2. Pictures of the African catfish carcass: a) natural positioning on the flat head and soft abdominal area, b) positioning on the flat part of the caudal area.
Rys. 2. Fotografie tuszy suma afrykańskiego: a) naturalne ułożenie na płaskiej głowie i miękkiej strefie brzucha, b) ułożenie na płaskiej części strefy ogonowej.
Source: Own study
Źródło: Opracowanie własne

The aim of the article is to analyse the conditions and possibilities of mechanisation of catfish de-heading due to the shape of the carcass, the morphology of its skeletal system and the arrangement of the abdominal organs.

FORM OF THE CARCASS, MORPHOLOGY OF THE BONE STRUCTURE AND THE INTESTINES

The typical shape of the fish body (carcass), including those from the carp family, is flat-sided – a freely laid fish lies on its side. In this context, the carcass shape of the catfish is not typical. The caudal area is formed traditionally – flat-sided, however the head and the anterior abdominal area is flattened perpendicular to the caudal area. The flat-shaped head and the soft area of the lower abdomen determine the free position of the carcass of the fish. The fish lies on the soft part of the abdomen, as shown in the picture (Fig. 2a). The arrangement of the carcass on its side (flat caudal area), as shown in the picture (Fig. 2b), is unnatural and unstable. The shape of the carcass and its natural arrangement results from the construction of the skeletal system of the head and spine. As it can be seen in the picture – Fig. 3 – the plane of the head

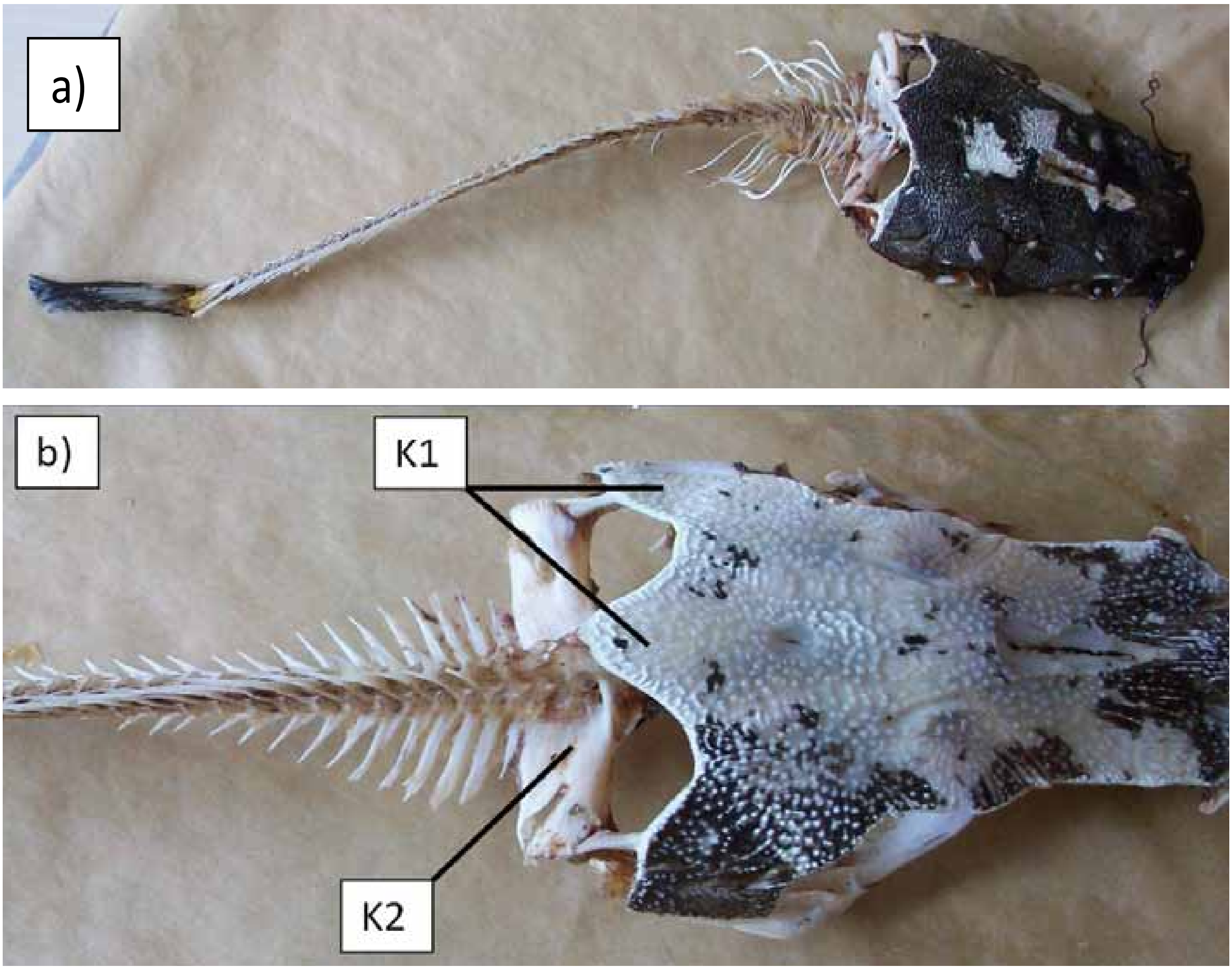

Fig. 3. Bone structure of the head and spine of the African catfish: a) view of the entire skeleton, b) head and part of the spine: K1 – head upper bone flap complex (peterotic), K2 – vertebral parapophysis bone complex (parapophysis of vertebrae); names according to [1].

Rys. 3. Układ kostny głowy i kręgosłupa suma afrykańskiego: a) widok całego szkieletu, b) głowa i fragment kręgosłupa: K1 – zespół kości górnego płata głowy (pterotic), K2 – zespół kości parapofiza kręgu (parapophoysis of vertabera); nazwy wg [1].

Source: Own study

Źródło: Opracowanie własne

Fig. 4. View of the insides of the abdomen of the African catfish.

Rys. 4. Widok wnętrzności brzucha suma afrykańskiego.

Source: Own study

Źródło: Opracowanie własne

determines the arrangement of the carcass of the fish. Due to the shape of the head bones, the bone complexes indicated in Fig. 3b can be distinguished. They are the upper flat bone flap (K1 – peterotic) and the transverse bone complex (K2 – parapophysis of vertebrae). From the K2 bone complex – parapophysis of vertebrae – the vertebrae of the spine begin. These head bone complexes, in combination with the spine, shape the flatness of the catfish head structure, the ventral area behind the head and the transition to the caudal area.

The photo (Fig. 4) shows the arrangement of the abdominal organs of the catfish. As can be seen in the picture, the abdominal cavity with its organs is in the area under the head bone complex K1 and K2 shown in Fig. 3b.

LIMITATIONS AND POSSIBILITIES OF DE-HEADING

The examples of possible de-heading cuts shown in Fig. 1 can be performed for the classic flat-sided fish carcass. The shape of the catfish's body does not allow such de-heading cuts to be conducted. A more natural arrangement of the catfish carcass for the de-heading treatment is the position resulting from the flatness of the head and the soft abdominal area, as shown in Fig. 2a and Fig. 3.

Possible machine cutting lines are shown in Fig. 5. The cutting line immediately behind the flat bone complex of the head upper flap is preferred for the full recovery of the flesh from the fish carcass. However, this incision leaves a parapophysis of vertebrae bone complex in the headless carcass and therefore requires additional cumbersome removal (trimming) procedures. Cutting along the line, behind the parapophysis of vertebrae bone complex, causes loss of a significant part of the carcass meat, thus reducing the technological and material efficiency. Moreover, both cutting planes pass through the abdominal organs of the fish. This is highly unfavourable due to the contamination resulting from the disturbance of the intestines and liver, including the gallbladder.

In case of fish with a standard flat-sided shape, the line of the de-heading cut can be identified by the outline of the gills, as shown in Fig. 1. However, in the case of the catfish, there is no clear, external distinction that would identify the edge of the head bone flap – peterotic (K1 in Fig. 3b) – and define where to cut. In the case of manual processing, the employee can determine the place of cutting by means of a touch evaluation. However, when using mechanised de-heading, such determination of the cutting line with a mechanical knife is difficult. In order to locate the line (spot) of cutting with a mechanical knife, tests of the morphology of the skeletal system depending, for example, on the weight or total length of the fish, or the width of the head are needed, or looking for methods of using the difference in the susceptibility of the fish carcass tissue in places where there is bone and where there are muscles.

Instructions (demonstration) of manual processing of the catfish carcass are shown on the website [10]. The recommended de-heading procedure consists of the following steps: incision of the back muscle of the carcass from the top, at the headbone, to the spine without cutting it; then incision on the abdominal side. The main de-heading is performed not by cutting the spine, but by breaking it at the base of the parapophysis of vertebrae bone (K2 in Fig. 3b). The process carried out in this way maximises the recovery of fish from the carcass and does not affect (does not corrupt) the abdominal organs.

Manual processing on a gastronomic scale (a few pieces daily) is not a problem. For full-industrial processing, the BADER company offers equipment with a capacity of approx. 50 pcs/min (annual scale of 5,000 tons), thus, as the scale of supply shows this is significantly too much, and also it is a process with large losses in the technological and material efficiency. With the processing conditions of the small industrial processing scale (processing with the efficiency of a few pieces per minute), the inconvenience of manual de-heading is a problem. A processing plant of this processing scale should have a machine for a mechanised de-heading procedure.

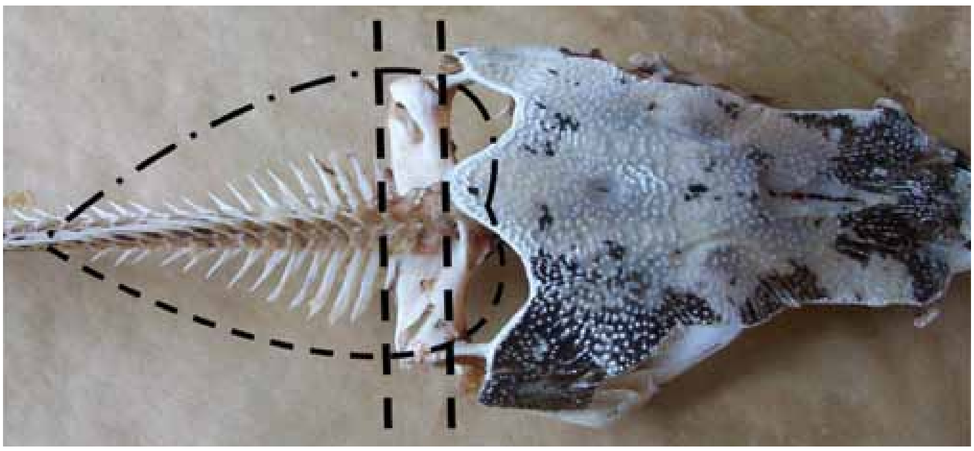

Fig. 5. Skeletal system of the head and part of the spine of the African catfish with marked: the abdominal area (dash-dot line) and the lines of the de-heading cut (dashed lines).

Rys. 5. Układ kostny głowy i fragmentu kręgosłupa suma afrykańskiego z zaznaczonymi: obszarem strefy brzusznej (linia kreska-kropka) oraz liniami cięcia odgławiającego (linie kreskowe).

Source: Own study

Źródło: Opracowanie własne

SUMMARY

1. In the pre-treatment of the fish carcass, the de-heading process is important due to its mechanical nuisance and the aspect of the technological and material efficiency.
2. The methods and devices developed and used for the de-heading of flat-sided fish such as those from the carp family cannot be used for mechanised de-heading of the catfish carcass.

3. Processing of catfish on a small industrial scale requires mechanisation of the de-heading process.
4. Due to the morphology of the catfish body structure, the mechanisation of the de-heading requires construction of a specialised device.

PODSUMOWANIE

1. We wstępnej obróbce tuszy ryby operacja odgławiania jest istotna ze względu na jej uciążliwość mechaniczną i aspekt wydajności technologiczno-materiałowej.
2. Do operacji zmechanizowanego odgławiania tuszy suma nie można zastosować metod i urządzeń opracowanych i stosowanych do odgławiania ryb płasko-bocznych jak ryby karpiowate.
3. Przetwórstwo suma w małej skali przemysłowej wymaga zmechanizowania operacji odgławiania.
4. Ze względu na morfologię budowy ciała suma, mechanizacja odgławiania wymaga skonstruowania specjalistycznego urządzenia.

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