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Carcass characteristics of marketable size Hilsa, *Tenualosa ilisha* (Hamilton, 1822)

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Abstract
The present study investigates carcass traits of market class Hilsa, *Tenualosa ilisha* (Hamilton, 1822) to calculate meat yield and provide baseline information for manual/machine processing. Specimens of hilsa fish ranging from 800 to 850 g (820.5±12.1 g) were collected from Howrah, West Bengal fish market. Carcass yield, offal yield and carcass cutability were assessed. The percentage of head yield was recorded 16.3%. Gutted yield and final dressed yield of 820 g market class hilsa was recorded to be 77.9% and 61.6%, respectively. The average meat: bone ratio in filleting and deboning was reported to be 7.2:1. The middle cut of hilsa fish exhibit the highest total yield percentage and highest meat yield. The proximate composition of all three cuts were estimated and found that fore cut of hilsa fish shown highest dry matter, ether extract and protein percentage followed by hind and middle cut.

Keywords: Indian shad, carcass yield, meat: bone ratio, proximate composition, cutability

1. Introduction
The Indian shad hilsa (*Tenualosa ilisha*, *Clupeidae*) is one of the most important tropical fishes in the indo-pacific region and has occupied a top position in the edible fishes due to its delicious taste, mouth-watering flavor and delicate culinary properties [1] (Nowsad *et al*. 2012). *Tenualosa ilisha* is a commercially important food fish species and always exhibit high consumer preference. Hilsa is considered as one of the tastiest fish due to its distinctly soft oily texture and it is a dark- fleshed fatty fish. *Tenualosa ilisha* of the subfamily *Alosinae*, family *Clupeidae*, and order *Clupeiformes* is a fast swimming euryhaline known for its cosmopolitan distribution in brackish water estuaries and marine environment in the Indo-pacific region and in the riverine environments where it migrates for breeding [2] (Pillay 1968). *Tenualosa ilisha* is the major component of fishing in the Ganga-Brahmaputra-Padma rives system. Hilsa is the state fish of West Bengal accounts for 15-20% of the total fish landing [3] (Bhaumik 2010). Major catch of hilsa about 95% comes from Bangladesh, India and Myanmar. About 60-70% hilsa are consumed fresh and the rest are exported to USA, EU, Japan and the Middle-East.
Present study on *Tenualosa ilisha* deals with processing yield in relation to body mass morphometrics. Carcass traits are good indicator of edible yield, indices that are easily and conveniently measures. They are also good indicator of body composition, growth and carcass flesh quality for routine analysis in fisheries [4]. Hanez *et al* [5] predicted carcass quality of common carp by computerized X-ray tomography. Ujjania and Kohli [6] used a truss network as an effective tool to describe body shapes of carp and quantify interspecies variability. The objective of this study was to characterize the carcass traits of marketable size *Tenualosa ilisha.*

2. Materials and Methods
Samples of hilsa fish were collected from Howrah fish market belonging to weight group 800 to 850 g. The samples were iced and sent to postharvest technology laboratory at CIFA, Bhubaneswar. Carcass weight, yield offal and cutability traits were determined following a standard carcass evaluation technique [7]. After dissection (i.e., evisceration, removal of head and fins) cutting and dressing was carried out. All characters were measured to the nearest centimeter

using a Vernier caliper and weighed with a standard top pan balance with a precision of 0.1 g (Kern CB3K0.1N). Total fish weight (g) and standard length (SL) in centimeter served to calculate the condition factor. The gutted hilsa fish were segmented into three parts according to fin location [from near the head to the pectoral fin (fore cut) (HPF), anterior to dorsal fin (middle cut) (ADF) and anterior to anal fin (hind cut) (AAF)] (Fig. 1 and 2) weighted separately and homogenized, placed on pre-weighed aluminum foil and then dried to a constant mass by slow oven heat at 70 ^{0}C for 12 h, to analyze the quantity of lipid, water and dry matter in each part in relation to the weight class of the fish, each dried part was powdered and preserved in labeled plastic bottles for analytical use. The different segments were weighted separately. Cross-section of these cuts were used to estimate the total muscle area by taking an impression and drawing is on graph paper to express in square centimeter (Fig. 3).

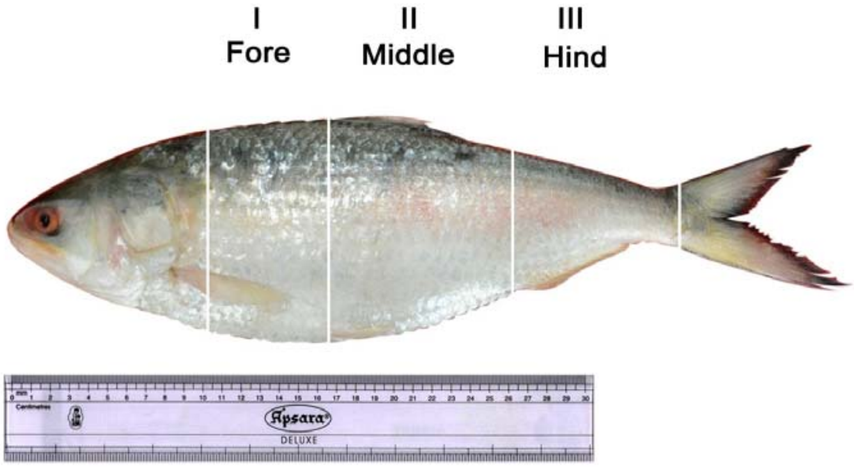

Fig 1: Morphological sites of three cuts in Hilsa fish

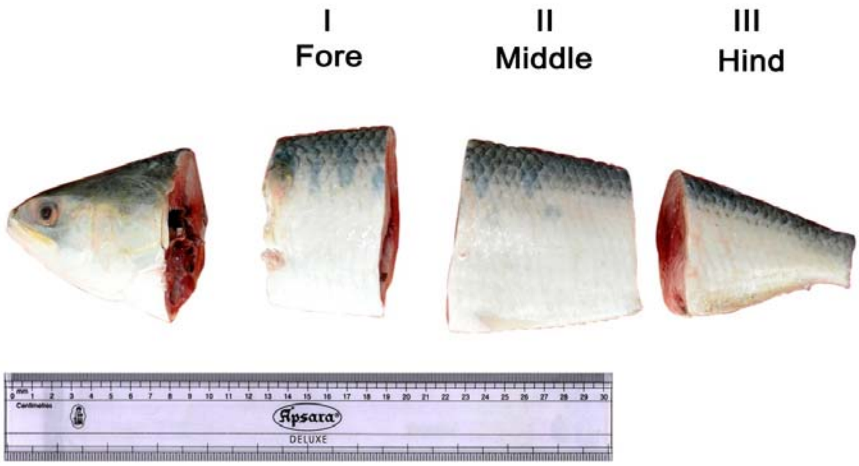

Fig 2: Locations of three Hilsa fish carcass cuts

Fig 3: Cross-section of carcass cuts from marketable size Hilsa

Fig 4: Cutability traits of *Tenualosa ilisha*

3. Results

Tenualosa ilisha, body traits, morphometric weights and condition factor are presented in Table 1.

Table 1: *Tenualosa ilisha* body morphometrics of sampled fish studied for carcass traits (Mean ± SD; n=10)

Traits	Mean ± SD
Fresh body weight (Kg)	820.5±12.1 (800 – 850 g)
Body length (cm)	40.1±0.8
Standard length (cm)	31.5±0.5
Condition factor (k)	2.59
Head length (cm)	8.5±0.6
Mouth length (cm)	6.5±0.4
Vertical width of mouth (cm)	4.2±0.4
Girth of HPF (cm)	25.1±0.2
Girth of ADF (cm)	28.3±0.3
Girth of AAF (cm)	21.4±0.1
Muscle area of HPF (cm^2)	32.1±1.3
Muscle area of ADF (cm^2)	39.3±1.8
Muscle area of AAF (cm^2)	28.5±1.1

HPF - head to pectoral fin; ADF - anterior to dorsal fin; AAF- anterior to anal fin.

Girth was equally reflected in the dimension of the muscle area, which is found to be higher in ADF followed by HPF and AAF. Offal yield traits of hilsa are given in Table 2. Head yield of hilsa was 16.3% and the viscera are 17.9%. Traditional evisceration mass was found to be 77.9% of the total weight. However, headless eviscerated yield was 61.6% and skinless dressed yield reached 60.5% of the total weight (Table 3). Filleting traits of *Tenualosa ilisha* was presented in Table 4. In the filleting process the two anterior round cuts produced 79.8% and the tail cuts producing only 20.36% of the total weight yield. Hilsa filleting traits indicate that the cutability percentage and the highest percentage of edible fillet is found in the middle cut followed by fore and hind cut. Meat bone ratio is highest in the middle cut (12.3) followed by the hind cut 5.8 and fore cut (4.8) on an average a 800g market class hilsa has meat to bone ratio of 7.2. Mean value (±SD) percentage of dry matter, percentage of moisture, percentage of ether extract and protein percentage of the three different cuts are given in Table 5. Dry matter, ether extract and protein percentage is higher in fore cut followed by hind and middle cut.

Table 2: *Tenualosa ilisha* offal trait yields (Mean ± SD; n=10)

Offal traits yield	Mean ± SD	%
Live weight (g)	820.5±12.1	-
Head weight (g)	132.5±21.2	16.3
Fin and tail weight (g)	11.4±1.1	1.40
Viscera weight (g)	145.2±18.5	17.9
Scales weight (g)	21.1±1.1	2.6
Gills weight (g)	24.8±1.9	3.1
Skin weight (g)	5.1±1.1	0.63

Percentile value on live weight basis

Table 3: Carcass dressing traits, marketable size *Tenualosa ilisha* (Mean ± SD; n=10)

Carcass dressing traits	Mean ± SD	%
Live body weight (g)	820.5±12.1	-
Dressed body weight (g)	631.5±23.3	77.9
Headless dressed round weight (g)	499.1±12.8	61.6
Skinless dressed round weight (g)	490.8±12.5	60.5

Percentile value on live weight basis

Table 4: *Tenualosa ilisha* fish filleting traits (Mean ± SD; n=10)

Cut identification	Weight (g)	Yield (%)	Meat yield (g)	Meat (%)	Bone yield (g)	Bone (%)	Meat:Bone ratio
I Fore cut	167.5±10.1	33.6	133.4±6.8	26.7	28.1±4.8	5.6	4.8
II Middle cut	230.5±18.3	46.2	215.5±12.4	43.2	17.5±3.4	3.5	12.3
III Hind cut	101.5±8.5	20.4	89.8±4.9	18.0	15.5±1.8	3.1	5.8
Total weight(g)	499.5	-	±28.2	87.9	61.1±8.1	12.2	7.2

Percentile value on the basis of skinless round

Table 5: *Tenualosa ilisha* proximate composition of fore, Middle and hind cuts, 810.5±32.1 g market size class (Mean ± SD; n=10)

Traits	I Fore cut	II Middle cut	III Hind cut	Pooled
Dry matter (%)	49.2±1.9	47.1±2.1	47.3±1.8	47.8±1.9
Moisture (%)	51.4±1.8	52.8±1.9	53.7±2.1	52.6±1.8
Ether extract (%)	24.3±1.3	19.4±1.1	21.7±1.1	21.8±1.2
Protein (%) (N X 6.25)	18.1±1.9	19.6±1.4	21.8±1.4	19.8±1.6

Values are mean ± standard deviations on dry weight basis

4. Discussion

Study of physical structure of fish is important in order to understand the nutrition profile and quality changes of fish. In carps and catfishes the carcass yield and dressing percentage is significantly addressed by the weight of the head and viscera [8, 9]. In this study the evisceration yield was similar to earlier studies [10] (Dunham 1983). The final dressed yield percentage seems to depend upon the head size, whereby the head and offal components in carps have more influence on the yield than those of catfishes [11] (Jankowska *et al*. 2007). Cutability percentage of the middle cut was highest followed by the fore and hind cut. The growth of carp fishes is associated with changes in morphometric traits, carcass traits and proximate compositions. These changes are the result of differential development in the main tissues that compose the fish, i.e. bone, muscles and adipose tissues. Analysis of the mechanism of development of these tissues will provide future tools for the control of body morphometrics, important in determining the optimum size at harvest for maximum usable (marketable) yield in weight. The difference in the filleting percentage, however also depend on the method of dressing and the species type [12].

Selection for growth rate as well as dress-out percentage of fishes often result in development of muscles mass just behind the head, carps provides a clear demonstration of this effects [8, 13]. The muscle area varied according to the body shape and seemed to be inadequate for predicting the slaughter value of common carp (*Cyprinus carpio*, Cyprinidae). However, the fore cut has more ether extract followed by that of hind cut and middle cut. Fat deposition is highest in the dorsal fin region [5, 14] and similar result is obtained in the percent study. A 100 g hilsa contains 22.6 g protein, 19.5 g fat. Higher protein is obtained in the dorsal portion and higher lipid contents are obtained from the ventral protein of the hilsa fish. Hilsa gains significant fat contains in the brackish water environment [15]. The crude fat content of small, medium and large size fish was found to be 6.74-9.43, 8.94-12.56 and 11.25-17.87% in three different size groups of hilsa, showing a direct positive relation to the size of the fish [16]. An inverse correlation was observed between percentage of moisture content, ether extract, dry matter and percentage organic content (weight of cuts on a weight mass basis). The results are in general agreement with those reported in other investigation using rohu (*Labeo rohita*, Cyprinidae) [9] as well as Catla (*Catla catla*, Cyprinidae) [9, 17] mrigal (*Cirrhinus mrigala*, Cyprinidae) and silver carp (*Hypophthalmichthys molitrix*, Cyprinidae) [9]. Major changes in body composition of fishes are due to particularly variation in relative proportion of fat and water and changes in the nutritional status of the fish [14]. Genetic variation in carcass quality traits in culture Seabass (*Lates calcarifer*, Centropomidae) reported [18] showed that body weight composition was positively correlated with the percentage of fillets, viscera and visceral fat to a decrease in percentage of head and muscle lipids, which in turn could be reduced by directing fish selection toward achieving a genetic goal. If we are to control product qualities in the form of body composition and flesh quality yield by understanding the interactions between and among the economically important traits [19].

5. Conclusion

The data and information obtained in this study represent first step towards understanding the yield and composition of market class *Tenualosa ilisha* in terms of optimal processing approach. Extensive studies on Hilsa carcass yields, using different size classes would lead to an accurate weight-composition table which could be used to modify the carcass composition of cultured hilsa fish to meet consumer's preference for specific characteristics.

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