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Evaluation of the Carcass and Commercial Characteristics of Carps

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Abstract

The role of carcass evaluation techniques in aquaculture research programs, especially in genetics, breeding, production management, feeding and nutrition, cannot be overemphasized. Knowledge of production efficiencies and growth potentials in relation to desired carcass attributes has provided an impetus to improvements in genetic selection techniques and management of aquatic food animals. Accurate, standard and uniform methods of carcass evaluation are critically important. A standard format developed for collection of data on carps is presented in this paper.

Introduction

Aquaculture has a low-energy expenditure and high-protein yield in comparison to other agricultural sectors. Since aquaculture production is affected by multiple factors, many characteristics must be measured and analyzed to explain production. The physical and chemical characteristics of the waterbody, seed quality, stocking density, season, culture system, feeding and harvesting patterns are important factors. Proper management of all these factors is essential for the successful operation of pisciculture activities. Usually a few major factors are considered at one time, while keeping minor factors at a given level. Even for this type of analysis, suitable variance functions are not available for comparisons of production parameters from different water bodies to observe treatment effects (Royce 1996).

The growth rate of aquaculture species depends on their genetic potential as well as several other factors. Some of the factors that influence the growth of fish are: genetic makeup, behavior, population dynamics, endocrinology, feed, etc. (Fig. 1). Any single factor should not be considered in isolation, even though it is difficult to optimize them together. Specific information on optimal growth patterns is lacking for many carp fish species. One solution would be to record production, growth rate and quality parameters under different culture conditions in a database and develop a model to identify optimum conditions for growth to serve as a guide to researchers and producers (Wathne 1995).

The growth rate is one of the most important traits for fish farming. A high growth rate increases production turnover and a fast growing fish reaches a higher body weight before

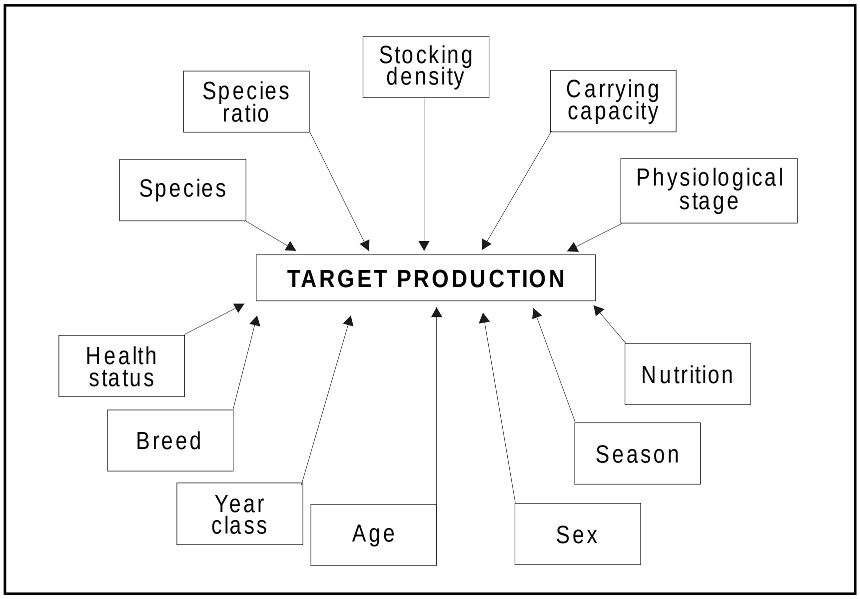

Fig. 1. Factors influencing the growth rate of farmed fish species.

the onset of sexual maturation. A medium to high positive correlation between growth rate and feed conversion rate has been recorded. Thus, selection for a high growth rate often results in improved feed conversion. Accurate prediction of the growth potential of a fish stock under given husbandry and culture conditions is an essential prerequisite for any aquaculture production research.

Carps have a high consumer demand. Cultured carps need to retain the quality and traits preferred by the consumers. So far, quality has been a function of species, body size and external appearance. Other traits of economic importance are condition scores, belly fat thickness, depot fat, distribution of fat in the meat, texture, water holding capacity, flavor and organoleptic acceptability. In salmon, trout and other commercial fish species, these traits have shown high heritabilities, indicating that it is possible to select for them.

Cultured fish species are being improved for a multitude of traits including growth rate, feed conversion efficiency, body shape, dress-out percentage and carcass quality. A variety of genetic techniques are used commercially, including selection, crossbreeding, hybridization, sex reversal and polyploidy to improve the quality and quantity of fish yield. A combination of methods for improvement (traditional, biotechnological, genetic engineering) will result in a genotype suitable for aquaculture (Dunham 1995).

Growth proceeds through the harmonious development of bone, muscle and adipose tissue. Changes in chemical composition result from differential growth of tissue. Very little is known of the morphometric traits during the development of carps and their genetic basis, but it seems likely that valuable criteria for selection for commercial use can be identified from information on the mechanism of bone and muscle development (Fauconneau et al. 1995). Reliable estimates of configuration and carcass parameters are needed for all traits of economic importance in order to predict the response to selection, choose among various breeding plans, relate physiological status of growth, select appropriate feed and nutrients, estimate economic returns and, above all, predict breeding values of candidates for genetic selection (Rye and Gjerde 1996).

The importance of raising the general quality of fish and fish products is now widely understood. Quality criteria vary widely and the preferred taste depends on tradition. It is possible to influence quality in the direction of consumer preferences. Feed and nutrients influence the quality by changing the chemical composition of fish meat (Wathne 1995). It is also possible to change carcass quality traits by breeding and selection (Rye and Gjerde 1996).

The development of fatty tissues associated with growth in carps is stimulated by the use of lipid-enriched or high energy artificial diets. Fat is accumulated in specific adipose tissue and the analysis of the relative development of this tissue can give valuable information on the accumulation of fat and its pattern of distribution in the body. Accumulation of fat has either positive or negative consequences for sensory evaluation depending on the source and composition of fat. Baeverfjord and Rye (1994) reported that in salmon some of the quality traits vary within the carcass. The fat percentage is higher in the anterior part of the carcass and lower towards the tail. In a fillet, the fat percentage is lower closer to the backbone and increases towards the skin and the belly.

Distribution of fat in the carcass is an important economic trait. Consumer preference for fat varies from location to location. It is very difficult to ascertain the optimum level of fat in a carcass. Generally, it is felt that a fat percentage of 16-18% in a fillet is too high. Excessive fat deposits reduce the quality of the fish. Increase in fat depots increases waste in processing. Dissection in and around the intestine is a standard method for checking the fat depot of a fish. There are several other methods available to measure fat content in a fish carcass: chemical analysis (AOAC 1995); Tory fat meter (Kent 1990); Near Infrared Reflectance Analysis (NIRA) (Wold and Isaksson 1997); Computerized Tomography (CT) (Rye 1991); and Near Infrared Transmitter Spectroscopy (NITS) (Wold and Isaksson 1997).

The characteristics of muscle and connective tissue also affect the sensory attributes of fish. Different muscle tissues of cyprinids have different fiber types. These tissues, together with the adipose tissue, compose the edible part of the carp and explain most of the protein retention. Protein content and composition are stable during development. The wide variability in the characteristics of muscle and connective tissues in commercial fish is related to their mode of development. It is especially true for the main contractile protein, myosin. The structural components and the organization of tissues are very specific and easily damaged. The degradation that takes place in the meat during harvesting and post-harvest handling and processing has important consequences for the sensory value of the meat. In freshwater species, the meat is generally soft with neutral odor and taste.

Intermuscular bones are common in the meat of some carp species. They are undesirable and pose problems in filleting and consumption as they are difficult to remove. It is possible to breed carps with a reduced number of intermuscular bones, vertebrae, ribs and dorsal fin rays.

Intensive fish farming practices have necessitated the development of technologies for selective breeding and genetic manipulation of stocks for traits of specific interest, such as faster growth, better meat taste and higher production. Analysis of desired carcass attributes helps in determining the growth potentials

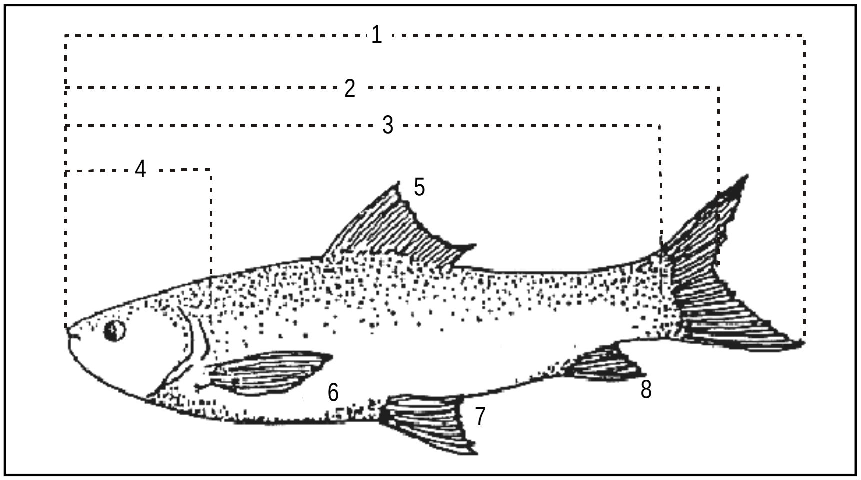

Fig. 2. Conformation and external anatomy of rohu (*Labeo rohita*). (1) total length; (2) fork length; (3) standard length; (4) head length; (5) dorsal fin; (6) pectoral fin; (7) pelvic fin; (8) anal fin.

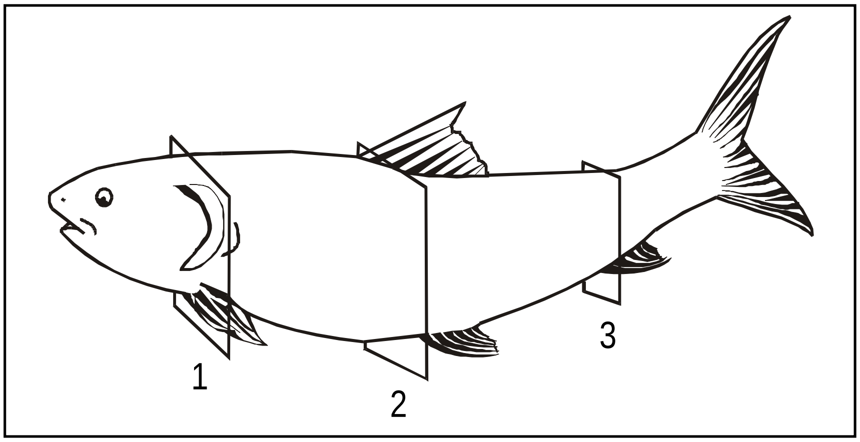

Fig. 3. Location 1 (PP); 2 (AD); 3 (AA) for body circumference and cutability traits measurement.

and production efficiencies. For this to be accomplished, accurate, standard and uniform methods of carcass evaluation are critically important. Therefore, a standard procedure and format for slaughter data collection has been made at the Central Institute of Freshwater Aquaculture, Kausalyaganga, India, for carp carcass evaluation.

Format for Data Collection

Carcass Database

Primary Data Sheet:
1. Accession no.
2. Case sheet no.
3. Date
4. Species
5. Age
6. Production type
7. Pond type
8. Sex
9. Year class
10. Physiological stage
11. Weight class
12. Body weight (g)

Carcass Conformation Data Sheet

(Figs. 2 and 3)

1. Total length (cm)
2. Standard length (cm)
3. Fork length (cm)
4. Body circumference (cut 1) posterior to base of pectoral fins (cm)
5. Body circumference (cut 2) anterior to base of dorsal fins (cm)
6. Body circumference (cut 3) anterior to base of anal fins (cm)
7. Cut 1, area of flesh in impression (cm^2)
8. Cut 2, area of flesh in impression (cm^2)
9. Cut 3, area of flesh in impression (cm^2)
10. Belly fat thickness (mm)
11. Condition factor

Carcass Cutability Data Sheet

Initial processing includes dressing (i.e., eviscerating and removing gills) and scaling (includes trimming away fins and head). Then cutability and flesh quality data are collected after making cut at PP, AD and AA (Fig. 3).

1. Head cut (g)
2. Head bone (g)
3. Head meat (g)
4. First body cut (g)
5. Second body cut (g)
6. Third body cut (g)
7. First body cut meat (g)
8. Second body cut meat (g)
9. Third body cut meat (g)
10. First body cut bone (g)
11. Second body cut bone (g)
12. Third body cut bone (g)
13. Total meat in carcass (g)
14. Total bone in carcass (g)
15. Meat: bone ratio

Flesh Quality Data Sheet

1. First body cut moisture (%)
2. First body cut ether extract (%)
3. First body cut protein (%)
4. Second body cut moisture (%)
5. Second body cut ether extract (%)
6. Second body cut protein (%)
7. Third body cut moisture (%)
8. Third body cut ether extract (%)
9. Third body cut protein (%)
10. Average flesh moisture (%)
11. Average flesh ether extract (%)
12. Average flesh protein (%)
13. Water holding capacity (%)
14. Muscle fiber diameter (mm)

Visceral Organ and Offal Data Sheet

1. Weight of viscera (g) (including abdominal fat and intestine)
2. Weight of liver (g)
3. Weight of swim bladder (g)
4. Weight of gall bladder (g)
5. Contents of gall bladder (ml)
6. Empty gut weight (g)
7. Empty liver weight (g)
8. Gills (g)
9. Head bone (g)
10. Head meat (g)
11. Dorsal fin (g)
12. Pectoral fins (g)
13. Ventral fins (g)
14. Anal fins (g)
15. Scales (g)

Important Codes and Formulae Deduced from Data Sheets

(Figs. 4 and 5)

1. Ungutted body weight (UBW) (to the nearest 20 g)
2. Body length (BL) (to the nearest cm)
3. Body circumference posterior to pectoral fin (BCPP)
4. Body circumference anterior to dorsal fin (BCAD)
5. Body circumference anterior to anal fin (BCAA)
6. Visceral weight (VW) (abdominal fat and intestine)
7. Abdominal fat score (AFS) (scored 1-5, with 5 indicating fattest)
8. Belly thickness score (BTS) (scored 1-5, with 5 indicating thickest)
9. Belly thickness (BT) (to the nearest mm) measured on the cut edge of the belly halfway between the pectoral and the pelvic fin
10. Meat color score (MC) (scored 1-5, with 1 indicating pale and 5 the most red meat when judged by inspection of the abdominal cavity after removal of the viscera)
11. Condition factor (CF) = ungutted body weight (g)/body length (cm)
12. Gutted body weight (GBW) (including kidney) = ungutted body weight – (weight of viscera + gonads + liver)
13. Dressing percentage (DP) = (gutted body weight/ungutted body weight) x 100
14. Gonad index (G1) = (gonad weight/gutted body weight) x 100
15. Viscera index (VI) = (weight of viscera/gutted body weight) x 100
16. Average belly thickness (ABT) is calculated as (BT+BTP+BTP2+ BTD1+BTD2)/5 BT, belly thickness to the nearest mm, measured on the impression of the cut edge at site 1 (PP) and 2 (AD)

Measures of Body Shape

The following traits can be calculated as measures of body shape.

17. BS1, Body shape 1 = CiD/BL x 100
18. BS2, Body shape 2 = THD/BL x 100
19. BS3, Body shape 3 = WD/BL
    Where CiD = Body circumference at position 2(AD)
    THD = body height
    BL = body length

Some more traits can be calculated as measures of the shape of each cross section.

20. SS1 (PP) = WP/THP x 100
21. SS2 (AD) = WD/THD x 100
22. SS3 (AA) = WA/THA x 100
23. SS4 = BTx1/WX, BT x 2/WX, BT/WX
24. SS5 = 0.5 * (II * HX * WX * 0.5 / AX)

Where HX, WX, THX, BTX 1 and BTX 2 traits are shown in Figs. 4 and 5. BT in belly thickness traits shown earlier and in WX was taken in mm while calculating SS4. For calculation of SS5 the area dorsal to the WX line was assumed equal to half the area of an ellipse with radii HX and WX/2.

Suggestions

Among the commercial characteristics of carps, flesh quality is becoming more important to the aquaculture industry. The consumer dictates the flesh quality and it is a very complex characteristic. An attempt has to be made to define and analyze flesh quality and its relation to carcass characteristics. Carcass quality traits must be defined exactly and should be possible to measure with a high repeatability. Some of the quality traits vary within the carcass. Therefore, a very precise carcass evaluation is necessary to arrive at any useful conclusion. To have an efficient program for improving growth and flesh quality traits of carps,

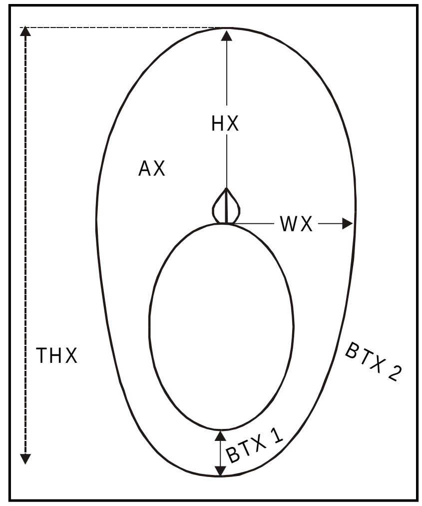

Fig. 4. Fish cut traits recorded on a cross section at location 1 (PP) and 2 (AD). Total height (THX); height (HX); width (WX); area (AX); and belly thickness (BTX1 and BTX2); X=P at location (PP); and X=D at location (AD).

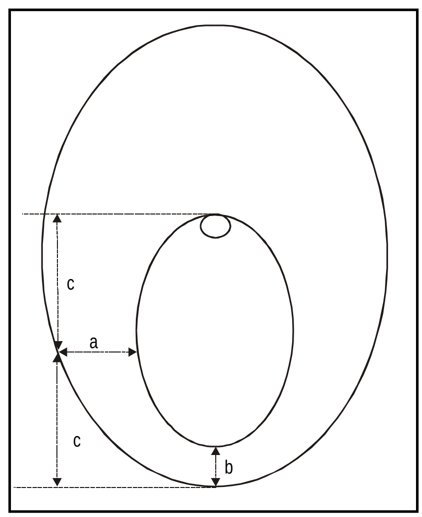

Fig. 5. Fish cut traits recorded on a cross section 1 (PP) and 2 (AD). Average belly thickness (ABT)=(a+b)/2.

it is necessary to test 10-15 fish from each family for carcass evaluation each year and to compile a database. The genetic gain will increase as more families are tested in each generation.

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