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Comparative study on qualitative and sensory characteristics of fresh and marine water fish meat

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Abstract:

Present study was conducted to compare the qualitative and sensory characteristics of fresh and marine water fish meat. Meat samples (n=30) from two fishes i.e. Rahou (n=15) and Khagga (n=15) fish meat was examined. Physico-chemical characteristic such as pH, water holding capacity, drip loss, cooking loss, protein, fat, ash and glycogen, the nutritive value and sensory analysis done according the established methods in Dairy and Meat Chemistry laboratory, department . The Rahou fish meat has higher pH value (6.66), water holding capacity (51.08±1.76), drip loss (3.37±0.79%) and cooking loss

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(40.44±1.99) compared to Khagga fish meat (pH value, 6.43; water holding capacity, 48.77±4.37%; drip loss, 2.75±0.72; cooking loss, 38.87±2.46). Further statistical analysis showed significant difference in values of all parameters. The average protein content (40.44±1.99), fat content (2.65%), ash content (1.00%) and glycogen content (3.39%) of Rahou fish meat was statistically higher than that of Khagga fish meat where protein was found as 38.87%, fat content as 3.29%, ash content as 1.66 and glycogen content as 1.56%. The average nutritive values in Rahou fish meat (115.71±11.51 K.cal) was significantly lower than that of Khagga fish meat (165.18±19.00 K.cal).The average appearance/color, odor/aroma, flavor/taste, body/texture and overall acceptability score of Rahou fish meat was recorded as 7.0±0.65, 7.48±0.66, 35.51±2.77, 23.74±1.54 and 7.78 ±0.69, respectively and that of Khagga fish meat as 4.24±0.95, 3.07±0.66, 25.32±2.59, 15.65±1.65 and 3.90±0.58, respectively. In conclusion, the pH, water holding capacity and drip loss were significantly higher in Rahou compared to that of Khagga fish meat. Moreover, Khagga fish meat was rich in protein and fat while poor in glycogen and ash contents compared to Rahou fish meat. Khagga fish meat was found more nutritive whereas the overall acceptability score of Rahou fish meat was high.

Key words: qualitative and sensory characteristics of fresh and marine water fish meat

1. INTRODUCTION:

Fish is considered as one of the prime sources of quality protein and a best alternative to meat. Worldwide production of fish and fisheries is approximately 154 million tons per year. Pakistan has potential of fishery due to availability of lakes, dams, and rivers. In Pakistan, every person consumes about 1.6kg fish per year which is considered as lowest rate compared to the average intake i.e. 18.5 kg per capita per year in the world (Can *et al.,* 2015). The management of fisheries is not properly developed in Pakistan, thus Asian development banks have started some projects to strengthen the institutional structure and infrastructure across the country (FAO 2003).There are about 193 fresh water and 250 marine water fish species in Pakistan. Fresh water species belong to class Actinopterygii, subclass Teleostei, 3 cohorts, 6 superorders, 13 orders, 30 families and 86 genera (Rafique *et al*., 2007, Rafique *et al*., 2012). The major economically important native fresh water fish fauna includes *Labeo rohita*, *Gibelioncatla*, *Cirrhinusmrigala*, *Cirrhinusreba*, *Channastraita*, *Channamarulius*, *Speratasarwari*, *Wallagoattu, Rita*, *Bagariusbagarius*, *Tenualosailisha, and Notopterusnotopterus*, *Nemacheilus* spp., *Tor macrolepis*, *Schizothorax* spp and *Clupisomanaziri* (Khan *et al*., 2011; Peter *et al*., 1999). While, marine water fish fauna in Pakistan includes shrimp (30 species), crab (10 species), lobster (5 species) and about seventy commercial species of fish such as Sea brae, Shark, Hilsa, Cat fish, Shrimp, Sardine, Mackerel, Tuna, Sole and Eel (Smeda 1997). The fish meat, one of the animal origin food sources is rich in valuable protein and low level of saturated fatty acids. Fish meat attains an important position among animal origin foods due to its structure and nutritive and protecting effects on human health (Busova, 2013). Omega-3 fatty acids are called as essential lipids that cannot be made by body itself rather some external sources are required to fulfill the body requirements. Fish, in contrast to other types of meat, has several important nutritional characteristics such as low level of cholesterol, superior quality protein and unsaturated fatty acids, containing the omega-3 type fatty acids (Huang *et al*., 2005; Terry *et al*., 2001; Nettleton, 1992).The digestibility of fish meat is very high because of lack of connective tissues (Kizilaslan and Nalinci, 2013). Risk of lethal disorders such as cardiovascular disease increases if there is insufficient intake of fish meat (Garaiova *et al*, 2013).In addition to the health values, fish meal has high economic value (Wasim, 2007). Looking at the nutritional properties and health promoting effects of fish, in many European countries, fish consumption is recommended twice a week (Scientific Advisory Committee on Nutrition, 2004; Welch *et al.*, 2002).Various studies have been carried out regarding health benefits of fish consumption. Fish meat plays pro-vital role in prevention of various disorders such as cardiovascular diseases, metabolic syndrome, asthma, cholesterol, Alzheimer's disease, hypertension, arthritis and cancer (McManus *et al.*, 2010; De Goede *et al*, 2010; Yamagishi *et al*, 2008). The fish meat contains Omega 3 fatty acids due to which it is considered as healthier meat than that of other animals (Das *et al.*, 2010).Rahou (*Labeo rohita)* is one of the indigenous fish species of the region, which is most commonly cultured in all types of the freshwater bodies. This fish is popular among consumers due to its taste and nutritional value. However, Khagga meat has attained it importance commercially (Gupta 2015). Additionally, it is rich is protein thus admired food with good taste. Phenotypically Khagga fish is identified with as having no scales on their surfaces thus often naked (Brouton, Michel 1996).The consumption of Khagga fish (*Rita Rita*) is not common in Pakistan due to scarce scientific knowledge on its nutritive value. Fish have attained key spot in due to its nutritive value, income generation, and employment and foreign exchange earnings. Therefore, information of fish composition is essential for its maximal utilization (Silva and Chamul, 2000). The present study was focused on determination and comparison of physico-chemical and sensory characteristics of Khagga (*Rita Rita*) and Rahou *(Labeo rohita)* fish meat.

2. MATERIALS AND METHODS

2.1. Raw material:

Fresh water fish and marine water fish meat were purchased from Hyderabad fish market. After removing scales, the carcass was obtained and used for further studies.

2.2. Micro Kjeldhal digestion and distillation unit

Micro Kjeldhal Digestion unit (LABCONCO Mod 60300-01) was used to digest the samples during determination of nitrogen/protein content in fish meat

2.3. Experimental procedure

Experiments were conducted to observe the qualitative and sensory characteristic of fish meats. The fish samples were collected during February to May, 2016. A total of thirty (n=30) fish meat samples; Rahou (*labeo rohita*) (n=15) and Khagga (*Rita rita*) (n=15) with approximately similar weight were purchased from Hyderabad fish market and transported under chilled conditions (4^0C) to Dairy and Meat Chemistry laboratory, department of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam for further processing. The samples were analyzed for macronutrients such as protein, fat, glycogen and total minerals; the physical characteristics such as pH value, water holding capacity (WHC), cooking loss (CL) and drip loss (DL) and finally on the basis of macro-nutrients calorific values were calculated. For analysis of sensory parameters, the fish meat was cooked by fried first then panel of judges was asked to taste and score for sensory attributes.

2.4. Analysis of physical characteristics

2.4.1. The pH value

The pH value of fish meat was determined by pH meter (Ockerman (1985). A total of ten grams of beef mixed with 90 mL of distilled water was transferred to beakers and an electrode along with temperature probe was inserted into the sample. The constant reading appeared on pH meter base was noted and recorded as pH value of fish meat.

2.4.2. Water holding capacity (WHC)

Water holding capacity was determined according the method reported by Wardlaw *et al.* (1973). Briefly, eight grams of meat sample were placed in a centrifuge tube together with 0.6M NaCl solution (12ml). The tube was centrifuged (4ºC) at 10,000 rpm for 15 min, and supernatant was decanted and measured. The difference between the volumes of NaCl (0.6M) used and supernatant was recorded as WHC.

$$\text{WHC (\%)} = \frac{\text{Actual weight} - \text{supernatant volume}}{\text{Actual weight}} \times 100$$

2.4.3. Cooking loss

Cooking loss of fish meat was measured according to the method as reported by Kondaiah *et al.* (1985). In brief, meat sample (20g) was placed in a polyethylene bag and heated for one hour in water bath at ~80 ºC to achieve an internal temperature of ~72ºC. Cooked out was drained and cooked mass was cooled and weighed to determine the weight loss using following formula.

$$\text{Cooking loss (\%)} = \frac{\text{Mass before cooking} - \text{Mass after cooking}}{\text{Mass before cooking}} \times 100$$

2.4.4. Drip loss

Drip loss was measured as described by Sen *et al.* (2004). Fish meat sample (50g) was placed in polyethylene bag with sealed cover and refrigerated (4ºC) for 24 hrs. It was then wiped and dried with filter paper and weighed. The difference among actual weight of sample and weight after refrigeration was assumed as drip loss.

$$\text{Drip loss (\%)} = \frac{\text{Actual weight} - \text{weight after refrigeration}}{\text{Actual Weight}} \times 100$$

2.5. Analysis of macronutrients

2.5.1 Total protein content

Protein content was determined according to the method of Association of Official Analytical Chemist (AOAC, 2000). The sample (2g) was digested using Micro-kjeldhal digester in the presence of catalyst (0.35g copper sulphate and 7 g sodium sulphate/potassium sulphate) where sulfuric acid (30 ml) was used as an oxidizing agent. The digested sample was diluted with distilled water (250ml). Then diluted sample (5ml) was distilled with 40% NaOH solution using Micro-kjeldhal distillation unit where steam was distilled over 2% boric acid (5ml) containing an indicator bromocresol green for three minute . The ammonia trapped in boric acid was determined by titrating with 0.1N HCl. The nitrogen percentage was calculated using following formula.

$$N\% = \frac{1.4(V1-V2) \times \text{normality of HCL}}{\text{Weight of sample taken} \times \text{Volume of diluted sample}} \times 250$$

Where,

V1 = Titrated value

V2 = blank sample value

While protein percentage was determined by conversion of nitrogen percentage to protein assuming that all the nitrogen in meat was presented as protein i.e. protein percentage = N%×conversion factor (CF). Whereas, CF is 100/N% in protein of meat and meat products i.e. 16.

2.5.2. Total fat content

Total fat content was extracted in Soxhlet Extraction Unit (Lablin Melrose park, ILL) as defined by AOAC (2000). Soxhlet extractor was set with reflux condenser and distillation flask which has been previously dried and weighed. Dried meat sample (2g) was taken into fat free extraction thimble and placed in extraction apparatus (Soxhlet). Then ether (150 ml) was poured into extraction flask and condenser was joined and placed on electric heater in order to boil the solvent gently. Extraction was carried out for 6hr. The solution was removed. Fat content was calculated by using formula

$$\text{Fat (\%)} = \frac{W2-W1}{W3} \times 100$$

Where,
W1=weight of empty distillation flask
W2=weight of distillation flask +Fat
W3= weight of sample taken
Where,

2.5.3. Glycogen content

The method reported by Kemp *et al.* (1953) was used to determine the Glycogen level in meat. In brief approximately 200 mg meat sample was placed in a centrifuge tube together with 5 ml of deproteinizing solution Trichloroacetic acid (5g) and Ag_2SO_4 (100mg) and filled up to 100ml with distilled water. The tube with sample were placed in water bath (100 ºC) for 15 min and there after cooled in running water and centrifuged at

3000 rpm for 5 min. one milliliter of clear supernatant and3ml of H_2SO_4 was taken in a wide test tube and mixed by vigorous shaking. The mixture was heated in a water bath (100^0C) for exactly 6 min and subsequently cooled in running tap water. The intensity of Color spectrophotometrically at 520mμ and concentration of glycogen was recorded from standard curve in term of glucose equivalents.

2.5.4. Ash content

Ash percentage was determined by Gravimetric method as described by AOAC (2000). The fresh minced meat sample of (5g) was transferred in pre-weighed crucible and transferred to muffle furnace (Nebertherm Mod; L9/11/8KM, Germany) set at (550^0C) for 5h. Ashed sample was transferred to desiccator having silica gel as desiccant. After 1h, the dish was weighed and the ash content as calculated applying the following formula.

$$\text{Ash (\%)} = \frac{\text{Weight of Ashed sample}}{\text{Weight of sample taken}} \times 100$$

2.5.4. Nutritive value

Nutritive value of Rahou and Khagga fish meat were calculated from the proximate analysis results by using the following generalized equation.

$$\text{Calories (per 100g)} = [(\text{\% protein})\ (4)] + [(\text{\% fat})\ (9)] + (\text{\% Carbohydrates})\ (4)]$$

Where,
4 = conversion factor of protein in kilocalories and
9 = conversion factor of fat in kilocalories

2.6. Sensory Analysis

All the fishes were fried and sensory analysis was performed by panel of judges as reported by (Meilgaard *et al.*, 1999). The hedonic scale score used for fish meat sensory analysis was 10 for color/appearance, 45 for taste/flavor, 10 for odor/aroma, 30 for body/texture and 10 for overall acceptability.

2.7. Statistical Analysis

Statistical analysis was performed using computer program, Student Edition of Statistix (SXW), Version 8.1 (Copyright 2005, Analytical software-USA). The data was organized and analyzed using statistical formula of summary statistics, under which descriptive statistics and analysis of variance (ANOVA) was performed. In case of significant difference existed, the means were further calculated using least significant difference (LSD) test at 5% level of probability.

3. RESULTS

3.1. Physical characteristics of fish meat

3.1.1. The pH value

The pH value of two different fish breeds, Rahou and Khagga were analyzed and result are presented in figure 1 and appendix-I. The minimum pH value in Rahou fish was examined as 6.61 whereas the maximum was recorded as 6.70. The CV% was computed as 0.42%. The minimum and maximum pH value of Khagga fish meat was found as 6.32 and 6.49, respectively. The CV% value was recorded as 0.70%. The average pH value of Rahou and Khagga fish meat was 6.66 and 6.43, respectively. Application of Analysis of variance on pH values showed significant difference ($P<0.05$) between both type of fishes.

3.1.2. Water holding capacity (WHC)

Water holding capacity of Rahou and Khagga fish meat showed a wide variation (Figure 1andAppendix-I). Water holding capacity of Rahou fish meat ranged between 47.75 to 53.13 %

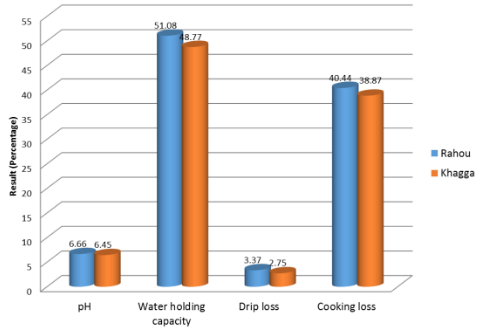
(CV, 3.18%) while that of Khagga was between 42.50 to 55.40% (CV, 8.52%). The average water holding capacity of Rahou and Khagga fish meat was 51.08 and 48.77, respectively. Statistical analysis; ANOVA (Appendix-II) revealed significant difference ($P<0.05$) in water holding capacity of both meat types.

3.1.3. Drip loss

Rahou and Khagga fish meats were examined for Drip loss and result are shown in figure 1 (Appendix-I and II). A remarkable difference was found in drip loss of Rahou and Khagga fish meat. Lower drip loss was found in Khagga (2.75±0.72%) compared to Rahou fish meat (3.37±0.79 %). The minimum and maximum drip loss of Rahou fish meat was 2.00% and 5.20%, respectively and that of Khagga fish meat was 1.84% and 3.98%, respectively. The CV% observed in Rahou fish variety (23.75%) was lower than CV% noted in Khagga fish meat (24.88%). Statistical analysis (ANOVA) (Appendix-II) showed significant difference between the drip losses of both fish meat samples.

3.1.4. Cooking loss

The results regarding cooking loss in Rahou and Khagga fish meat are depicted in figure 1 and appendix I. A wide variation in cooking loss was observed among both fish meat types. The minimum value for cooking loss in Rahou fish meat was found as 37.81% while maximum value was 43.54 % with computation of CV as 4.71%. However, the minimum cooking loss in Khagga fish meat was observed as 34.55% while maximum as 42.44% with CV% as 5.79%. The mean cooking loss in Rahou fish meat (40.44±1.99) was slightly higher in contrast to Khagga fish meat (38.87±2.46). Statistical analysis by ANOVA (Appendix-IV) showed non-significant difference ($P>0.05$) in mean cooking loss % of Rahou and Khagga fish meat.



Chemical characteristics of Rahou and Khagga fish meat

3.1.5. Protein Content Percentage

The results of protein content in Rahou and Khagga fish meats are depicted in figure 2 and appendix III and IV. The protein content of Rahou fish meat ranged from 17.87 to 21.75% with an average of 19.59±1.18%. While the protein content of Khagga fish meat was in between 21.87 to 37.43% with an average value of 35.48±3.14%. The CV was calculated for Rahou and Khagga was 6.05% and 13.143%, respectively. The ANOVA (Appendix-IV) showed statistical difference ($P \leq 0.05$) in protein content of both fish meat types.

3.1.6. Fat Content Percentage

Fat content analysis of Rahou and Khagga fish meat showed significant variation if results (Figure 2 and Appendix III). The fat content in Rahou fish meat was recorded in between 1.60 to 3.58% and that of Khagga fish ranged between 2.0 to 4.28%. Coefficient of variation (CV) was found higher (23.62%) in Khagga fish meat than that of Rahou fish meat (22.61%). Moreover, ANOVA (Appendix-IV) revealed that fat content in Khagga fish meat (3.29±0.78%) was significantly higher ($P \leq 0.05$) than Rahou fish meat (2.65±0.60).

3.1.7. Ash content Percentage

The ash content ranged from 0.3% to 1.07% in Rahou fish meat (CV as 11.25%) and 0.56 to 0.76% in Khagga fish meat (CV as 4.14%) (Figure 2; Appendix-III). Statistical analysis (ANOVA) (Appendix-IV) revealed the significant difference (P≤0.05) in ash content of Rahou and Khagga fish meat (1.00 and 0.66%, respectively).

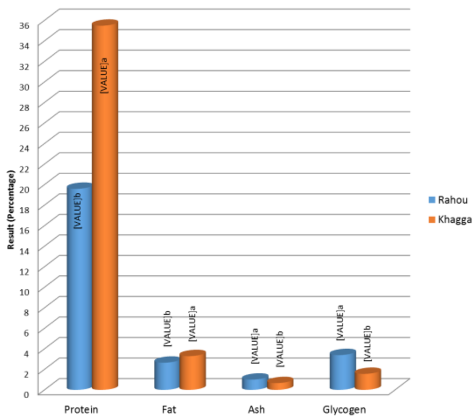


Figure 2. Chemical characteristics of Rahou and Khagga fish meat.

3.1.8. Glycogen content Percentage

Glycogen level in Rahou and Khagga fish meats was determined (Figure 2 and Appendix III) and found that the glycogen content of Rahou fish meat (3.38±1.43%) was comparatively higher than that of Khagga fish meat (1.6±0.53%). The minimum glycogen level in Rahou and Khagga fish meat was found as 1.4%and 0.35%, respectively whereas the maximum values were recorded as 5.42% and 2.52%, respectively. The CV% was computed as 42.3% and 34.03% for Rahou and Khagga fish meat, respectively. Based on ANOVA (Appendix-IV) results, it was found that the glycogen content of Rahou and Khagga fish meats was significantly different (P≤0.05) from each other.

3.1.9. Nutritive value of Rahou and Khagga fish meat

A wide variation in nutritive value of Rahou and Khagga fish meat was observed (Figure 3; Appendix V). Nutritive value in Rahou fish meat was ranged from 106.50 to 180.89 kcal/100g and that of Khagga fish meat ranged in between 94.44 to 122.84 kcal/100g. The CV recorded was higher in Rahou fish meat (11.64%) compared to Khagga fish meat (8.55%). Statistical analysis (ANOVA) (Appendix-VI) revealed significant difference among both type of fish meat samples; nutritive value of Rahou fish meat was significantly lower (105.70±18.68 kcal/100 g) than that of Khagga fish meat (160.57±9.02 kcal/100 g).

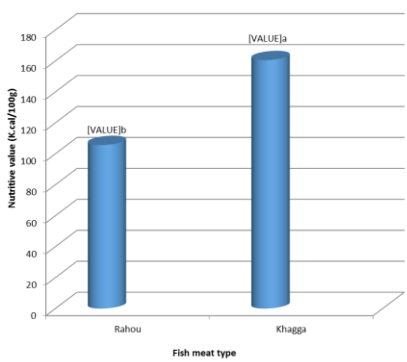


Figure 3. Nutritive value of Rahou and Khagga fish meat.

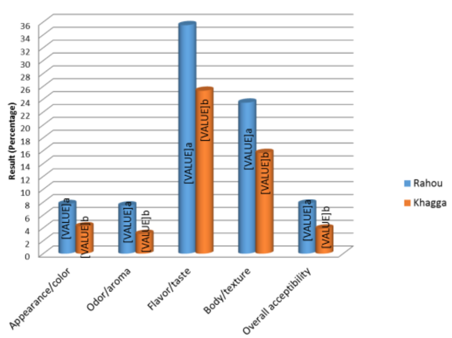


Figure: 4 Sensory Characteristics of Rahou and Khagga Fish Meat.

4. DISCUSSION

Fish consumption is widely recognized possible health improving practice which has got more attention, in particular during last two decades (Hoge Gezondheidsraad, 2004; Sidhu, 2003). The present study was undertaken to evaluate the physico-chemical characteristics of Rahou and Khagga fish meat available in the Hyderabad markets, Sindh Pakistan.

The average pH value of Rahou fish meat (6.66) was higher than that of Khagga fish meat (6.43). This variation in pH of both fish types could be due to different habitat (fresh and marine water). The pH of fresh water and marine water is 6.5 and 7.5, respectively (Huss, 1988). As a consequences of oxygen depletion after death, the aerobic glycolysis is no longer possible and anaerobic glycolysis take over (Romans *et al.*, 2001), resulting in accumulation of lactic acid in muscle (Aberle *et al.*, 2001; Henike, 2004 which in turn may decline pH value of meat.Water holding capacity in Rahou fish meat (51.08±1.76) was higher than that of Khagga fish meat (48.77±4.37).The difference in water holding capacity could be due to variation in pH values in both meat types. The higher muscle pH results in high water holding capacity because at high pH value. The negative charge of myofilaments creates strong repulsive electrostatic forces within the filaments which pushes the filament apart, swells up the lactic and hence increases the space where the water is lodged (Warriss *et al.*, 1999).Water is the major component of meat. It is lost from the tissue during processing which ultimately affects the quality, in particular, texture of the products. Drip is the reddish proteinious fluid in meat. The drip loss in Rahou fish meat (3.37±0.79%) was higher compared to the drip loss in Khagga fish meat (2.75±0.72). Drip loss occurs due to denaturation of muscle protein because of decline in pH, Sarcomere shortening and Myosin degeneration (Warriss, 2000; Offer, 1991; (Honekel *et al.*, 1986), which in turns result in shrinkage of myofibrillar component followed by expulsion of fluid into extracellular spaces (Warriss, 2000). Results of present findings disagree with Hui *et al*. (2001), who observed the lower ultimate pH and a greater drip loss. Further, Gracey *et al*. (1999) found that onset of rigor mortis caused by rapid breakdown ATP in muscle and produced greater discharge of fluid from the muscles.It was observed that the cooking loss of Rahou fish meat (40.44±1.99) was statistically higher than that of Khagga fish meat (38.87±2.46). Most water in muscle is held within the myofibrils in the space between the thick filaments (myosin) and thin filaments (actin) and some water is located in the connective tissue (Offer *et al*. 1989). Cooking loss occurs due to moisture evaporation and dripping of melted fat (Mansour and Khalil, 1997). During the cooking, denaturation and aggregation of heat induced protein occurs which leads to shrinkage of both the filament lattice, collagen and also exposition of hydrophobic areas of the myofibrillar structure, which allows new intra and inter-protein interactions that resulted in more dense protein structure due to the pressing of the water out of muscle cells leading to water loss (Straadt *et al*. 2007).

Khagga fish meat contained more protein content (35.48±3.14) to that of Rahou fish meat (19.59±1.27). These results are in accordance with the findings of Ananthi *et al*. (2015) who reported high protein content in fresh water fish. The result of present study are disagreed with the findings of Mahboob *et al*. (2004) who found higher protein content in fresh water fish, labeo rohita fish meat (20.68±0.02%) and wild type fish 17.76±0.02%. Similarly, Abbas *et al*. (2013) observed higher protein content (18.45%) in catfish meat (freshwater fish). According to nutritional status of Rita fish meat are within required nutritional range of humans (Abbas *et al*., 2013).Fish lipids are considered as of high quality being rich in cholesterol, triglyceride and essential fatty acids. The lipid content in fish meat can influence its product quality by interaction with other components. Average fat content of Rahou fish meat was comparatively low (2.65%) than that of Khagga fish meat (3.29%). Based on fat content and crude protein, all farm fish species are ranked as lean (fat contents lower than 5%) and high protein (greater than 15%)(Rahman *et al*., 1995; Standby, 1976). Furthermore difference in lipid content between both types of fishes might be contributed by various factors such as environment, species and/or diet (Mahboob *et al.,* 2004). Generally, it is considered that the buildup of lipids occurs during feeding season and decrease during spawning, however the main site of lipid storage is muscle. Season and sexual maturity could be other contributing factors in fat content variation (Manoharam and Subbulakshmi, 2016). Lipid storage variation occurs during breeding and nutrition period. During breeding period, the lipids mobilizes from the liver and muscle for the development of gonads (Castell *et al*., 1972)The average ash content of Rahou fish meat (1.00±0.04) was significantly higher than that of Khagga fish meat (0.66±0.07). Habitat could be the major cause of this variation in total mineral contents. The basic causes of change in the ash content are usually variations in the amount and quality of food that the fish eats and the movement it makes (Murray and Burt, 1969). Normally the ash content range gives an indication that the fish samples may be good sources of minerals such as calcium, potassium, zinc, iron and magnesium (Bolawa, *et al*., 2011).The average glycogen level was found to be higher in Rahou fish meat (3.39±1.43%) as compared to that of Khagga fish meat (1.56±0.53%). The variation in glycogen content could be attributed by environmental conditions, health status of fish and type of food. Stress is one of the prime factors which cause production of lactic acid even before slaughtering which ultimately results in sudden drop in pH immediately after slaughter.

The nutritive value may be calculated from the estimated macro-nutrient content of the food. The macro-nutrient content could vary due to various factors such as age, sex, season, type of feed and breed of fish could be the major factors (Ananthi *et al.*, 2015; Mojto *et al.*, 2009; Mahboob *et al.,* 2004). The older animals have higher calorific values as compared to young animals (Mojto *et al.*, 2009). In this study, fresh water fish (Khagga fish, 165.18±19.00 K.cal) showed dominancy in terms of nutritive value compared to marine water fish (Rahou fish meat, 115.71±11.51 K.cal). However, the results of Manoharam and Subbulakshmi (2016) were in contradiction; the nutritive value of marine habitat was dominant over fresh water forms. These changes are assumed probably due to minerals and fatty acids contents of the water (Murray and Burt, 1969).

Overall results regarding sensory analysis showed that Rahou fish meat was judged more attractive than Khagga fish meat. The average appearance/color, odor/aroma, flavor/taste, body/texture and overall acceptability score of Rahou fish meat was recorded as 7.68 ±0.69, 7.48±0.66, 35.51±2.77, 23.74±1.54 and 7.78±0.69, respectively however that of Khagga fish meat was 4.25±0.99, 3.07±0.66, 35.51±2.77, 15.65±1.60 and 3.90±0.58, respectively. The results of the present study were supported by Khan *et al.* (2012) who found increase in mean values of different sensory attributes of Rahou fish. Many factors such as temperature, internal enzymes like proteases, glycogen content are key factors which attribute to the organoleptic properties of fish meat. Along the processing line, washing is the major step where bad smell of the fish meat can be declined (Elyasi *et al.*, 2010). Color is one of the important indicators of overall sensory characteristics of food products. The color depends on fish freshness, raw material used and cooking conditions. The muscle color (myoglobin) can be affected by washing process (Chen and Chow, 2001).

CONCLUSIONS

It has been concluded from present study that:

The pH, water holding capacity and drip loss were significantly higher in Rahou compared to that of Khagga fish meat. However, non-significance difference was found in cocking loss of both fish types.

Khagga fish meat was rich in macro nutrients i.e. protein and fat while poor in glycogen and ash contents compared to Rahou fish meat.

Based on the macronutrients, the Khagga fish meat was found more nutritive compared to that of Rahou fish.

The overall acceptability of Rahou fish meat got remarkably higher attraction by sensory judges and won higher score.

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