5. DISCUSSION

Of the many species of fish caught, a significant proportion constitutes commercially unimportant and hence they are treated as under utilized species. Currently, most of the underutilized species are processed by different methods such as curing and production of value added products, which do not involve high costs (Yu et al., 1998). In accordance with the above statements, the present study was undertaken with the processing of one of the underutilized species of fishes, Sufflamen capistratus. Justification of the observation of Yu et al. (1998) that, underutilized fish have been processed into useful consumer products is made in this study. By-products, by-catch and or trash fish, trimmings or rejects of other fish processing industries and meat of low value species can be used to produce Value Added seafood Products (Brundaban Sahu et al., 1996). Hence in the present study, Value Added Products are made using trash fish.

Freshness of fish is an important factor influencing functional characteristics of fishery products (Spencer et al., 1989). Kamal et al. (1996) evaluated freshness of raw fish using grade and score system. Likewise, evaluation of freshness of raw S. capistratus is also carried out using grade and score system. Quality Index Method (QIM) is based on the significant sensory parameters for raw fish and a score system from 0 to 4 demerits points (Jonsdottir, 1992). The QIM gives scores of zero for very fresh fish, while increasingly larger totals result, as fish deteriorate. In the present study, the score of the QIM for the raw experimental fish is ‘0’, which indicates that it is very fresh.
It has been rightly said that quality can be good, only if raw material handling is of the desired standard (Gokhale, 1995). In order to maintain the fresh quality, special attention must be applied to gentle handling as well as to speed up the chain of events from catch to landing / processing / consumption (Leif Kraus, 1996). Special attention is applied to maintain the fresh quality in the present study also.

High quality value added products like keropok and fish wafers were developed by employing fresh fish along with addition of sufficient amount of salt and other ingredients in the present study. This is in accordance with the suggestion given by Cheow Cheong Seng (1998), for producing keropok of superior quality. Drying is carried out to remove excess water from the surface of the products. This technique was also employed by Ramachandran et al. (1995). It makes one full day and a half for the product to dry (Subasinghe, 1996).

In one of the recent reports, changes that took place in blue crab meat were investigated by Pinar Yerl Tkaya et al. (2002), by means of sensory assessments, chemical analysis and physical measurements. Quaouich (1997) have also pointed out that the laboratory analyses are a means of monitoring the preventive system to ensure that the products quality is effectively operated.

Studies by Sally Achaya Subhapholsiri (1997) indicated that, a multitude of bacteria, introduced during handling from the air, earth, facilities, equipment and even human beings, invade the fish. Minced meat products must be properly handled before, during and after cooking, to avoid food poisoning bugs (Anon., 2004). As afore-mentioned, the aseptic handling of raw materials and fishery products were followed in the present
study. As Sirilak Suwanrangsi (1995) subjected the developed fishery product to bacterial examination (for Total Plate Count, *E. coli, Staphylococcus aureus, Vibrio cholerae, Salmonella sp., Shigella sp., Listeria monocytogenes, Vibrio parahaemolyticus* and *Enterococci*), in the present study, microbiological examinations for Total Plate Count (TPC), coliforms (*E. coli*), *Salmonella sp., Shigella sp., Staphylococcus aureus, Vibrio cholerae* and *Vibrio parahaemolyticus* were carried out. Although the Total Plate Count method does not demonstrate freshness (of the products), it gives an indication of the risk of spoilage involved (Margaret Masette, 1999). The incubation temperature of 37°C resulted in lower bacterial counts when compared to the counts at 22°C (Liston, 1980; Margaret Masette, 1999). This situation is similar to that found in the present study. Only colonies which were Too Least To Count (TLTC = < 30 CFU/g) is noticed when examined for TPC and all the other microorganisms selected for the present study show nil results, when plated on selective (specific) media at 37°C.

Madhavan (1994) cited that hygienic practices play a vital role in seafood processing and therefore great care must be taken to ensure quality of seafood, meant for human consumption. He also explained that it may not be possible to produce an end product of good quality, out of a good quality raw material, unless necessary care and precaution are taken during handling, processing, storage, transport etc. From the present results, it is evident that, great (hygienic) care and precaution were taken during the application of different handling and processing procedures.
In the present study, protein is estimated by the method of Lowry et al. (1951), unlike Venkataramani et al. (1979), who employed a different method. Protein content of sundried *S. leptolepis* tissue was studied by Venkataramani et al. (1979), which was about 52.25%. Marginal increase of protein content dried mackerel throughout the storage period was observed by Dinesh Kumar et al. (1997). A similar phenomenon is observed in the present study also i.e. from 36.44 ± 0.53 to 36.97 ± 0.73% and 38.28 ± 0.06 to 40.23 ± 1.97% protein content was observed in keropok and fish wafers respectively in storage period upto 75 days.

The carbohydrate content of both keropok and fish wafers show a slight decrease (keropok from 46.86 ± 0.48 to 46.76 ± 0.37% ; fish wafers from 45.79 ± 0.87 to 44.84 ± 0.03%) during the 75 days period of study.

Dinesh Kumar et al. (1997) reported that, the lipid content of the products of mackerel increased during storage. Similar effect was also observed in the present study also (keropok : from 14.42 ± 0.49 to 15.10 ± 0.25% ; fish wafers : from 13.27 ± 0.46 to 13.91 ± 0.12%).

TMA is the most important fishy odour-producing component (Xue et al., 2000). Minced fish normally contain larger amounts of TMA than fillets, because the process of mincing causes an immediate increase in TMA values (Siah et al., 1998). More recently, Ravendra Kumar Singh et al. (2005) studied the TMA values of the frozen stored product of *Nemipterus japonicus* and reported that, it (TMA) increased gradually from 0 to 2.8 ± 0.2 mg/100g. Unlike this situation, the TMA values of the products of *S. capistratus* of the present study increased successively (keropok : 1.46 ± 0.05 to 38.96 ± 0.002 mg/100 g ; fish wafers : 0.71 ± 0.01 to 19.84 ± 0.03 mg/100g) till the end of the storage period (75 days). From the present
observation, it may be inferred that, the storage of fishery products (which were prepared from fish minces) at room temperature for a longer period of time (days) may increase the TMA values.

A number of chemical compounds are used as quality indices of fishery products. Some of the volatile basic nitrogenous compounds have been used frequently. Howgate (1982) noted that, TVB-N was even present in fresh fish because of ammonia, which was one of the major components of nitrogenous volatiles. All volatile basic compounds increased during storage (Xue et al., 2000). Kamal et al. (1996) showed an increase of TVB-N from an initial value of 5.6 to 27.20 mg/100g during the frozen storage of *Hilsa ilisha*, for a period of 75 days. However, in the present study, the TVB-N contents increased rapidly (keropok: 3.57 ± 0.002 to 60.97 ± 0.07 mg/100g; fish wafers: 2.33 ± 0.02 to 51.10 ± 0.24 mg/100g) from initial to 75 days of storage condition. Total volatile bases may be used for fish near the limit of acceptance as 30 mg/100g (Margaret Masette, 1999). In the present study, the TVB-N values go beyond the acceptable limit only after 45 days of preparation of keropok and after 60 days of preparation of fish wafers. From Margaret Masette's (1999) point of view, it may be inferred that the keropok samples are in a state of rejection after 45 days of preparation and that of fish wafers only after 60 days of preparation.

In the present investigation, the FFA contents showed an increase in order throughout the storage period (keropok: 7.0 ± 0.03% to 14.20 ± 0.04%; fish wafers: 7.73 ± 0.02 to 21.55 ± 0.04%). This trend is in agreement with that of dried mackerel fish throughout the storage period (Dinesh Kumar et al., 1997). The present result revealed that, FFA values may increase, as the
oxidation process proceeds. This was also noticed by Kamal et al. (1996) in *H. ilisha* fish during frozen storage up to 75 days.

Venkatramani et al. (1979) described that, moisture content below 20% prevented the growth of moulds and found that, 4.12 to 10.71% was the moisture contents of twelve sun dried carangid fish species. A moisture content of 0.85% or below will prevent the growth of all pathogens including *Staphylococcus aureus* (FDA, 2001). This condition is similar to that of the present study (keropok: 0.40 to 0.60%; fish wafers: 30 - 50%).

In 1988, Siah et al. studied the pH values of *S. leptolepis* and *A. nobilis* fishery products. Similarly, the pH values of *S. capistratus* products were investigated in the present study and found out little acidic from 6.44 to 6.83 in keropok and 6.50 to 6.78 in fish wafers.

The general appearance of a fishery food products are extremely important one (Francis, 1977; Mac Dougall, 1988). Organoleptic evaluation for taste, colour, flavour, juiciness and texture are conducted for fishery value added products by Yu et al. (1998). Szczesniak (1963) proposed the classification of physical (textural) properties of foods, based on their mechanical, geometrical and other characters. The odours of a product are detected when its volatiles enter the nasal passage and are perceived by the olfactory system (Meilgaard *et al.*, 1987). Schultz (1964) studied the odours of food substances using a nine-modular system such as fragrant, burnt, goaty, etherish, sweet, rancid, oily, metallic and spicy. Spoiling can be reliably detected sooner with smell and taste tests, than with other test methods (Anon., 1995). Korac *et al.* (1996), rated the sensory attributes (appearance, texture and flavour) of oysters on a score sheet. In the present study also, the sensory analyses were carried out on evaluation sheets. From
the assessments made by the assessors, it may be understood that, both the keropok and fish wafers were unfit to remain in an acceptable conditions after 60 days of preparation and hence, they may be subjected to rejection. In accordance with the description made by Yu (1997), that shapes and sizes of keropok and fish wafers were varied very much.