STUDIES ON THE EFFECT OF PURGING THE FRESHWATER PRAWN *MACROBRACHIUM ROSENBERGII* IN EXTENDING ITS ICED STORAGE LIFE

By

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DECLARATION

I hereby declare that this thesis entitled "STUDIES ON THE EFFECT OF PURGING THE FRESHWATER PRAWN *MACROBRACHIUM ROSENBERGII* IN EXTENDING ITS ICED STORAGE LIFE" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or any other similar title, of any other University or Society.

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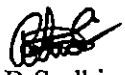

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INTRODUCTION

I INTRODUCTION

Seafood exports constitute an important sector in the export trade of India. During the year 1993-94, quantity of seafood exported was 2,43,960 tonnes valued at 2,503.62 crore rupees. Prawns formed the major item of seafood exported, contributing about 35% of the total quantity; which comes to 86,541 tonnes valued at 1,770.73 crore rupees (MPEDA 1994).

The contribution made by the giant freshwater prawn, *Macrobrachium rosenbergii* commonly called as 'Scampi' to the total export of prawns is negligible. The availability of this species to the industry was the main constraint owing to the fact that the species is facing the threat of stock depletion with pollution, over exploitation etc. posing serious problems to the survival of the species. However, the increased demand for this prawn in both local and overseas markets has contributed significantly towards the popularity of this species in aquaculture operations.

There are many advantages to selecting this species for culture. They have a faster growth rate, compatibility with various fishes in composite culture, good adaptability to varying salinities, hardy nature, ready acceptance of supplementary feeds, high monetary value and most of all high consumer rating within and outside the country. Its production is 200 tonnes / annum (Anon. 1994). From 1992 onwards owing to the government encouragement, culture of *Macrobrachium rosenbergii* has gained momentum considerably with a view to increasing export and earning the much needed foreign exchange.

The total export of scampi from Kerala during 1989-90 is estimated to be 38

tonnes (Sadanandan *et al.* 1992). The demand among processors exceeds the actual supply of the prawns. There is considerable demand for frozen scampi in the overseas market. Since large-sized prawns fetch higher prices in the world market, *Macrobrachium rosenbergii*, being the giant freshwater prawn, has immense scope for export.

The processing industry faces many problems with this 'giant' prawn, such as the development of white crust on shell, soft shell, loosened shell, pink discolouration of the meat, mushiness of the cooked meat etc. during iced storage (Joseph *et al.*1992). Frozen scampi is reported to undergo rapid deterioration in quality. Scampi frozen in still air, brine solution and liquid nitrogen loose elasticity (Nip and Moy, 1979).

The anticipated larger production of *Macrobrachium rosenbergii* by aquaculture, and also the need to transport it from remote freshwater farms to distant processing plants necessitate iced storage. Hence iced storage and the subsequent spoilage characteristics need to be studied.

Macrobrachium rosenbergii is a benthic omnivore and very often after harvest the gut is seen to be loaded heavily with food and mud. Usually *Macrobrachium rosenbergii* is processed in 'headon' product style and hence the gut can create quality problems during storage. Purging, as done in bivalves, can be an answer in reducing the gut contents.

Purging is the process of evacuating the gut of partially digested food, mud, sand etc. This can be done by maintaining the animal live in aerated freshwater with

continuous water flow. Purging can be done in large containers which will simulate a pond condition and also will eliminate any stress.

In this study an attempt is made to clean the gut by purging the animal in freshwater and also to study any quality improvement brought about by purging the animal, during subsequent iced storage.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

2.1 Purging of prawns

One of the promising methods to extend the shelf life and improve the quality and texture of prawns can be purging. This allows the animals to 'purge' or clean their gut of food, thus improving the general eating quality. In addition, this method allows prawns to clean themselves of silt which becomes attached to their gills during harvesting (Lee, 1979). Nip *et al.*(1985a) studied the effect of post harvest purging of the giant freshwater prawn *Macrobrachium rosenbergii*. They purged the animals for 18 hours over night to determine the effect of purging on the animal's muscle pH value, ammonia content, soluble / insoluble collagen ratios, texture profile (peak / plateau height ratios) and their overall appearance. Experimental results showed no significant difference ($P \leq 0.05$) between the purged prawns and control in their muscle pH value, ammonia content, soluble / insoluble collagen ratios, peak / plateau height ratios. However, with both control and purged prawns stored on ice, the decrease in peak height / plateau height, increase in pH, ammonia content and the soluble / insoluble collagen ratios with ice-chilling time were highly significant ($P \leq 0.01$). Purging helped to improve the appearance slightly.

2.2 Quality changes during iced storage

2.2.1 Biochemical changes.

Chemical changes in ice stored sea foods were mediated by a combination of bacterial action and endogenous enzymatic activity, according to Flores and Crawford (1973). Farooqui *et al.* (1978) have observed a significant correlation between the mean

organoleptic response (MOR) and the various objectively measured changes during cold storage of trawler caught shrimps from Karachi-Makron coast. Likewise a correlation between the activity of adenosine deaminase and AMP deaminase and the traditional spoilage indicators such as total volatile nitrogen, total plate count and organoleptic evaluation was obtained in the storage studies of pink and brown shrimp of Gulf of Mexico (Cheuk *et al.*, 1979). Riaz and Qadri (1979) and Velankar *et al.* (1961) do support the use of chemical analysis in conjunction with bacterial examination. Bailey *et al.* (1956) differentiated three phases in the quality of ice stored whole prawns with particular reference to the organoleptic characteristics correlated with alpha amino nitrogen levels. According to Siang and Tsukuda (1989), chemical indices are used to measure components involved in the break down process of fish tissues, after death, by internal enzymes. However, because of the high biological variations found in different organisms, chemical indices must be used carefully, and in conjunction with information from the other tests.

2.2.1.1 Alpha amino nitrogen.

Alpha amino nitrogen as a spoilage index for sea food is having various controversial openions. Clark and Almy(1917 a)found some increase in amino nitrogen with increase in spoilage. After that several workers have reported a favourable correlation between sensory judgement and amino nitrogen content of fish, while others have questioned the usefulness of amino nitrogen as a measure of early fish spoilage (Farber, 1965). According to Cantoni *et al.* (1978) the estimation of alpha amino nitrogen is useful in evaluating the freshness of prawns in certain conditions.

Velankar and Govindan (1958) suggested that the determination of amino nitrogen must be of use in the studies on crustacean spoilage. They found crustacean muscle to contain over 300 mg of free amino nitrogen per 100 g of muscle whereas in fish it was only 1 / 10 th of this value. The high content of free amino acids in crustaceans greatly facilitates bacterial growth and presumably explains their ready spoilage (Velankar and Govindan, 1957, 1958; Ranke, 1959; and Simidu, 1961). According to Pillai *et al.*(1961), the alpha amino nitrogen in fresh prawns ranged from 117 to 227 mg%, For *Palaemon sp* it increased from 226.8 mg% to 261 mg% during 5 hours of storage at room temperature and for headless prawns alpha amino nitrogen decreased from 107.40 to 97.05 mg% during 18 hours of storage at chill room but for peeled and deveined sample the AAN content decreased from 117.0 mg% to 34.65 mg% during 14 hours of storage in ice. This decrease is due to the increased leaching action since larger flesh surface is in contact with ice and water. Quite contrary to this the head-less prawns did not show any significant changes after chilled storage or after freezing. According to Ceccaldi (1982) high content of free amino acids is for the osmoregulatory function and increases prior to moulting. Chung (1977) reported that the development of alpha amino nitrogen in iced fish and shell fish is related to the degradation of proteins and the growth of bacteria. Chen *et al.*(1990) reports that alpha amino nitrogen of iced prawns increased significantly after 14 hrs of iced storage. This increase is considered to be the result of proteolysis of prawn meat. According to Pedraja (1970) free amino acids are responsible to a significant extent

for the taste and odour of shrimp and other marine animals. Amino acids comprise much of the non protein nitrogen of shrimp and appreciably contribute to shrimp flavour (Hashimoto, 1965 and Nair and Bose, 1965) with glycine contributing to the sweetish taste (Rao and Bai, 1975). Govindan (1972) points out that the loss of characteristic fresh flavour during iced storage is because of the leaching out of soluble nitrogenous constituents. According to Lakshmi *et al.* (1962b), during iced storage of headless prawns, alpha amino nitrogen decrease only gradually. Baily *et al.* (1954) did not include amino nitrogen among the tests which showed definite changes in the prime quality of ice-stored prawns but considered it among other tests for judging the relative quality. According to Reppond *et al* (1979) free amino nitrogen content did not change for 4 days of iced storage in *Theragra chalcogramma*. Vyncke (1978) found that alpha amino nitrogen is of no use in determining the freshness of thornback ray during 10 days of iced storage. According to Uchiyama *et al.* (1966) the amount of free amino acids was observed to be fairly increased during iced storage of plaice. Matsumoto and Yamanaka (1991), while studying the influence of Chloramphenicol on the post mortem biochemical changes of Kuruma prawn during storage at 5°C, found that the free amino acid content increased in both treated and untreated prawns. According to Shaban *et al.* (1987) during iced storage of Kuruma prawn there is an increase of free tyrosine, this increase is considered to be due to the action of the endogenous enzymes (Cobb *et al.*, 1974).

Campbell and Williams (1952) has reported an increase in amino nitrogen in iced Gulf coast shrimps but Fieger and Friloux (1954) observed a decrease in the amino

nitrogen in frozen gulf shrimp. Iyer *et al.* (1969) reported that the loss of alpha amino nitrogen during 12 days of ice storage for peeled and deveined, headless and whole shrimp are 88-92%, 80-81%, 61-66% respectively. Velankar and Govindan(1958) had reported a decrease in the amino acid content which was attributed to leaching. They do not suspect bacterial action since bacterial population is found to be low, especially during the early stages, while decrease in amino nitrogen is most rapid. Velankar *et al.* (1961) had observed that free amino acid nitrogen concentration represents the resultant of an increase in the free amino acids due to the degradation of protenoid substances and a decrease due to their utilisation by bacteria, both processes presumably proceeding simultaneously. Velankar and Govindan (1959) had indicated that free amino nitrogen reflects the number of days elapsed in iced storage and that it may be used in assessing the changes in iced prawns before the onset of bacterial spoilage. Freezing of prawns has been shown to cause reduction in amino nitrogen content, though frozen storage has not been shown to cause further reduction (Velankar and Govindan, 1959). According to Pedraja (1970) free amino acids in prawns increase during the first stages of storage and after reaching a peak they begin to decrease. The decrease in free amino nitrogen, if any, might be due to bacterial or enzymatic action or even due to osmosis. Leaching of free amino acids during iced storage of shrimp has been observed by Velankar and Govindan (1959), Iyengar *et al.* (1960), Waterman (1966), Pedraja(1970), Cobb *et al.* (1973, 1974) and Afser (1980).

Nair *et al.* (1971) reported an initial decrease in alpha amino nitrogen followed by an increase in freshwater fish (Mrigal). The decrease was suspected due to deamination.

Studies on products packed in polythene bags to avoid contact with ice (Cobb *et al.*1974) showed that all the free amino acids increase, except taurine, aspartic acid, serene, glutamine, aspargine and glycine which do not change much, while arginine and proline decrease in the tails of white shrimp (*Penaeus setiferus*). With small shrimp tails (<7.5g) in ice, the amino acid glycine and presumably alpha amino nitrogen leached from shrimp at a logarithmic rate which was a function of the time on ice and the square root of the weight of the shrimp tail. Cobb *et al.* (1976) reported that when the shrimp tail is about 5 g or greater, the rate of leaching becomes a function of the cube root of tail weight. Since variation in the rate of alpha amino nitrogen loss from shrimp was contrary to that expected if simple diffusion or surface area were the determining factors, the reason for this phenomenon has to be established. According to Basu and Khasim (1985) the leaching effect was more significant on TVN than on amino nitrogen contents in iced stored *Chanos chanos*. Sastry and Srikar(1986) observed that the alpha amino nitrogen content decreased from 89.84 to 12.49 mg% in the cuttle fish *Sepia aculeata* stored in ice for 7 days. Perigreen *et al.*(1987) observed that the alpha amino nitrogen content of *Channa striatus* decreased during iced storage. According to Jacob *et al.* (1962) alpha amino nitrogen level fell in the order Round < Headless < P&D during iced storage of prawns.

The natural flora of shrimp have little effect on the free amino acid content during storage(Cobb and Vanderzant, 1971).Cobb *et al.*(1974) observed that initial amino

acid content of white shrimp tails varied with season and with the area of catch. However, it can be concluded that crustaceans and molluscs contain free amino acids in quantities several times higher than all other aquatic animals (Guptha and Govindan, 1975).

During transportation of live grass prawn the AAN content increased from 234 to 260 mg N / 100 g (Chen *et al.*, 1990).

2.2.1.2 Total volatile bases.

The tests for volatile bases (VB,TVB,VBN) have had a long history and the support of the FDA (Stansby *et al.*, 1957; Hilling *et al.*, 1958 and Liston *et al.*, 1961). The earliest report found on the use of ammonia or volatile bases as an index of spoilage was that of Eber (1891). While a measure of NH_3, TMA or DMA used to determine early stages of spoilage found certain degrees of success (Paladino, 1943; Horie and Sekine, 1954 and Wittfogel, 1958), the bacterial count, formol titration and pH were rather unsatisfactory. Farber (1965) has reviewed the use of volatile base nitrogen compounds as an index of spoilage till the 1950s. Velankar and Govindan (1959) suggested TMA and VBN as "dependable indicators of distinct spoilage" for Indian prawn stored in ice. VBN has also been used for determining the acceptability of raw salmon for canning (Akiba and Tanikawa, 1969),and some workers have recommended VBN in combination with a taste panel for assessing quality in frozen fish (Jendrusch, 1967 and Kietzmann,1967).In some areas VBN was considered as good an index as hypoxanthine (Van Spreekens,1969). Rehbein and Oehlenshlaeger 1982) and Stockemer and Nieper(1984)were also some of the

investigators who used VBN as an acceptable spoilage indicator. It was also true in the case of Almanoos *et al.* (1984) who believed "TVB is a widely accepted index for evaluating changes in the quality of fishery products and the variation of TVB in fresh fish muscle is due to the formation of TMA from TMAO by bacterial activity; small amounts of DMA are also produced by enzymatic activity".

However, volatile bases become detectable too late (Guardia and Hass, 1969) and were consistent neither in fresh fish (Paladino, 1943) nor in frozen fish (Sigurdsson, 1947). Karnicka and Jurewicz (1974) could not detect any significant change in the content of TMAO, TMA and TVB in frozen fish stored for three months. All in all VB is not a reliable indicator of early changes in quality (Gould and Peters, 1971).

VBN has been found to correlate well with any of the other indices of spoilage. Bramsnaes (1951) published comparable results using TMA, VBN, pH, bacterial count, volatile reducing substances (V.R.S)and taste panel. Hinnard (1922) suggested the ratio of the content of total volatile base nitrogen to that of total nitrogen as a useful index of fish spoilage. Luna (1971) correlated VBN, pH and total aerobic count as the best indices of quality of shrimp. However, Cobb and Vanderzant (1975) reported a negative correlation ($r = -0.97$, $P < 0.01$) between TVN / AAN ratio and the potential shelf life of brown shrimp and white shrimp. They also noted the indirect correlation between TPC and TVN / alpha amino nitrogen ratio.They found that increased TVBN values were due to bacterial spoilage and some bacterial species produced volatile nitrogen more rapidly than others. TVB values had good correlation with organoleptic evaluation (Woyeda and

Ke, 1980). Cantoni *et al.* (1978) suggests that the ratio of TVN / alpha amino nitrogen of Cobb *et al.* (1974) is probably the most accurate index of shrimp quality because it is based on the post mortem production of basic volatile nitrogen by both bacteria and enzymes, but it can be influenced by the loss of volatile and amino acid nitrogen following the loss of liquid from muscular tissue after death. In some conditions, the value of the single components TVN or alpha amino nitrogen can be of more use in evaluating freshness. According to Cattaneo *et al.* (1980) TVN / alpha amino nitrogen ratio and the index of tyrosine complexes were found adequate for judging the state of freshness or preservation of meat and fish products out of the thirty four chemical, physical biological or physicochemical methods which they have done. Botta *et al.*(1984) studied the six different published methods for determining TVB-N and sensory assessment of raw or cooked fish.

Generally there is an increasing trend in VBN values as the fish gets spoiled. Clark and Almy (1917a, b and 1920) reported that TVB-N content increased during storage of shucked oysters and in white meat fish. But Fieger and Firloux (1954) found that TMA and volatile bases were relatively constant during the initial period and then increased significantly in iced stored headless shrimp. Studies on squid during frozen storage exhibited gradually increasing trends in VBN values (Joseph *et al.*, 1977). The increasing trend of VBN values evident in the case of hake (Quaranta and Curzio, 1983), Pacific coast shrimp, *Pandalus jordani* (Matches, 1982), frozen stored whole and headless freshwater prawn *Macrobrachium rosenbergii* (Hale and Waters, 1981), and Indian major

carps (Chakrabarti, 1984) all go to support the view that the production and accumulation of volatile bases go hand in hand with a general decline in quality.

Prawns in fresh condition showed TVN values of 8.4 to 21.5 mg% (Pillai *et al.*, 1961). According to them for *Palaemon* sp the TVN values increased from 8.40 mg% to 12.88 mg% during 5 hours of storage at room temperature, for headless prawns the TVN values decreased from 11.9 mg% to 10.5 mg% during 18 hours of iced storage. Velenkar *et al.*(1961) reported that when prawn is stored in ice without contact with ice the TVN content increases slightly upto 3 days of storage and increases rapidly from the 10 th day of storage, and the increase is more rapid in whole prawn than in the headless prawns. According to Lakshmi *et al.* (1962a) the TVB of *Penaeus indicus* was 12.03 mg / 100 g on the initial day and on the 5 th day of iced storage it decreased to 6.5 mg / 100 g and on the 12 th day of storage it increased to 10.14 mg / 100 g. Skipjack and plaice stored in ice showed a rapid increase in TVN during 1-3 days of storage and did not show any significant variation till 9 th day of iced storage (Uchiyama *et al.*1966). Shrimp stored in ice for 18 days had VBN 20 mg% or more (Jung *et al.*, 1972). In Cann's(1974) report it was 19 to 27.2 mg N / 100 g for shrimp in fresh condition but after 18 days it reached values as high as 82 mg / 100 g of flesh. Out of 22 frozen shrimp samples imported from tropical areas, 8 samples contained VBN values higher than 3 mg / 100g (Kawabata *et al.*, 1975). It is noted that the VBN content of the fresh *Mytilus edulis* muscle and shell liquor were 2.11 mg% and 1 mg% respectively (Lee *et al.*, 1975). In prawn there was a net increase in TVN ranging from 6.7 to 60.1 mg N / 100 g in 10-15 days of iced storage

(Cobb *et al.*, 1976). Joseph *et al.* (1977) found a VBN increase from 3.21 to 18.21 mg% during 0 to 6 days in iced storage of squid. VBN values of 30-40 mg N / 100 g in silver belly muscle at the beginning of storage (Jayaweera *et al.*, 1980) ; an increase from 22 to 31 mg / 100 g in freshwater prawn in 14 days iced storage (Angel *et al.*, 1981); and 7.1 mg / 100 g in fresh krill (Suh and Yun, 1982) are worth mentioning here. Cheuk *et al.* (1979) found a constant TVBN value for brown shrimp during the first 11 days on ice, and during the first 15 days for the pink shrimp. Lakshmanan *et al.* (1984) assessing the quality of fish and shrimp landed at Cochin fish harbour, during a period of 3 years found out that 10.1% of the samples had TVN values more than 30 mg% with a percentage unacceptability of 5.5 based on a 10 point hedonic scale. White muscle is known to have higher volatile base nitrogen than dark muscle (Obatake *et al.*, 1985). The increasing trend of VBN is also clearly evidenced from studies on *Metapenaeopsis barbata* which showed an increase from 15.3 to 26.8 mg / 100 g in 15 days of iced storage (Ho *et al.*, 1986). Chen *et al.* (1990) reported that volatile base nitrogen accumulated in both iced and oxygenated grass prawns (*P. monodon*) during 26 hrs of storage and transportation period. Iced prawns demonstrated a more rapid increase in VBN than the oxygenated prawn. For the oxygenated prawn the VBN ranged from 3.50 mg / 100 g to 10 mg / 100 g at the 26 th hour of transportation and for the ice stored prawns the variation was from 3.5 mg/100 g to 16.71 mg /100g at the 26 th hour

of storage. Nip *et al* (1985a) found increase in ammonia during iced storage of *M.rosenbergii* and purging did not show any statistically significant change in the ammonia content. According to Joseph *et al.* (1992) TVB content of *M.rosenbergii* is 15.2 mg N / 100 g of meat. This is very high when compared with other marine prawns. High values of TVBN was reported for freshwater fishes (Joseph *et al.*, 1988 and Bandhyopadhyay *et al.*, 1985)

Despite the innumerable questions raised against the credibility of VBN as a reliable spoilage index, there have been a number of investigators who have fixed lower and upper limits of acceptability with regard to VBN values in seafoods. Tillmans and Otto (1924) found that the total volatile bases increased with the onset of spoilage of such fishes as cod, haddock, eel and sea pike; they suggested an upper limit of 30 mg N / 100 g for acceptability. Yamamura (1933), Tanikawa (1935), Montgomery *et al.* (1970), Cobb and Vanderzant (1975), Cobb *et al.* (1976 and 1977), Cantoni *et al.* (1978), Cheuk *et al.* (1979) and Woyewoda and Ke (1980) have also suggested the same limit while Glassman and Rochwarger (1929) considered 20 mg N / 100 g as the upper limit. However, Wierzhchowski (1956) considered 60 mg N / 100 g as the upper limit of acceptability. Samples with TVN / alpha amino nitrogen ratio values more than 1.3 mg N / g were usually evaluated as poor (based on appearance and odour) by plant quality control personal (Cobb *et al.*, 1973).

Sato (1958 and 1960) studied the VBN and amino nitrogen in fresh market fish and the changes in spoilage, employing Conway's micro diffusion method, which he found

useful. According to Botta *et al.* (1984) TCA extraction / steam distillation method could be followed when variability of results could be tolerated. But Stockemer and Kruse (1985) suggested a new method in which the sample is extracted by perchloric acid followed by steam distillation in an automatic distillation unit.

2.2.1.3 Nonprotein nitrogen.

This fraction includes : free amino acids; volatile nitrogen bases, particularly ammonia; certain bases, such as trimethyl amine-oxide, which after death is reduced to trimethyl amine; creatine, which occurs in almost the same amount in all classes of fish but is absent in crustaceans; taurine, is claimed to exist in flesh and liver (Asikari *et al.*, 1938; Minato, 1949 and Jones, 1954)

According to Pillai *et al.* (1961) Non protein nitrogen and Alpha amino nitrogen values of peeled and deveined prawns show a decrease after being in the chill room and also after freezing. This is due to the leeching effect. However, headless prawns do not show any significant changes in the above constituents either after storage in chill room or after freezing. Jacob *et al.*(1962) reported a fall in levels of total nitrogen and NPN during 12 days of iced storage of *M. affinis*.The loss for whole prawn was from 0.789 mg% to 0.233 mg%, for headless prawns from 0.789 mg% to 0.252 mg% and for peeled and deveined sample from 0.789 mg% to 0.098 mg%. Iyer *et al.* (1969) found that during 12 days of iced storage of prawns in the PD form, the NPN loss was 72 - 76% in the cooked frozen material and during 4 - 5 days the loss was 45 - 70%. Similarly for the HL and whole prawn the NPN loss after 12 days of iced storage was 60 - 63% and 40 - 45 %

respectively. According to Lakshmi *et al.* (1962a) during storage of headless prawns in ice for 12 days the non protein nitrogen showed a gradual fall from 684.7 mg / 100 g to 300 mg / 100 g. According to Joseph *et al.* (1992) the NPN content of *M.rosenbergii* is 0.490%, and according to Sherief *et al.* (1992) NPN ranged from 320 to 440 mg N / 100 g of meat.

2.2.1.4 pH

Simidu *et al.* (1955) observed crustacean muscle showing a tendency to become alkaline rather rapidly during iced storage. He added that this is because of the presence of abundant extractive amino nitrogen in the flesh which results in the production of large amounts of volatile base nitrogen. Iyengar *et al.* (1960) found pH of meat together with its bacterial count as an useful index of spoilage in ice stored shrimp. According to Chung (1977) and Chung and Lain (1979) the pH of shrimps and prawns is a good index of freshness and can be correlated with the VBN / alpha amino nitrogen ratio (Chung and Lain, 1979). They also found a pH of 7.8 as a critical margin of acceptability. But Pillai *et al.* (1961) did not consider pH as an index of spoilage as they found that the variation of pH within the course of a 24 hr iced storage period was only of the order of one unit of pH. However, high pH values of shrimp (more than 7.95) are indicative of spoilage (Baily *et al.*, 1954). The pH of spoiled brown shrimp ranged from 7.8 to 8.0 (Cobb *et al.*, 1973). Shrimp with a pH of more than 8 does not offer acceptable commercial commodities (Villanueva, 1973). According to Nip *et al.* (1985a) any significant increase in pH is an indirect indication of muscle (protein) degradation due to the production of alkaline

substances such as ammonia and other amines. According to them, there is a gradual increase in pH during storage of *M.rosenbergii* in ice and there is no significant difference between the control and purged sample at $P \leq 0.05$. Waters and Hale (1981) reported slightly higher pH values in *M.rosenbergii* during the first few days of iced storage. According to Shaban *et al.* (1987) in ice stored Kuruma prawn the pH increased from 7 to 7.9 during 1 week of storage in ice, and according to them the increase of pH during iced storage is due to bacterial production of volatile amines during the spoilage process. Chen *et al.*(1990) found that during 26 hours transportation of live prawn with oxygenation the pH increased from 6.84 to 7.31 and for the same time of iced storage the pH increased from 6.84 to 7.38.

2.2.2 Sensory evaluation.

The oldest and still the most widespread means of evaluating the acceptability and edibility of fish are the senses - smell and sight, supplemented by taste and touch (Farber, 1965). It is probable that objective quality measurements will never play an important part in fish trade considering the complexity and variability of the process of spoilage and the fact that quality is not just dependent on freshness (Ruite, 1965). Farber (1965) strongly feels that the line dividing fish that are still fresh from those with some early signs of spoilage is not well defined and is most often subject to difference in personal opinion. It is the subjective taste panel that is used as the standard to determine the accuracy of any objective test (Gould and Peters, 1971) and is very important in determining the acceptability of all food products Govindan, 1972). It is also a most reliable method for

evaluation of the freshness of raw and processed fishery products (Iyer, 1972). He adds, "fishery products are having their own characteristic flavour and aroma which are mostly complex in nature, which vary with species and type of treatment applied and which none of the objective methods so far developed can singly bring out successfully". Organoleptic properties were also used by Perez (1979) to assess the quality of the frozen prawn *Penaeus brevirostris*.

The importance of organoleptic evaluation as a primary standard with which to compare other tests has been discussed by Jenson (1956). Several investigators have reported a favourable correlation between sensory judgement and the amino nitrogen content of fish, while others questioned the usefulness of amino nitrogen as a measure of early fish spoilage (Farber, 1965). Waters (1978) found a good correlation for chemical and microbiological parameters with that of organoleptic evaluation in determining the refrigerated shelf life of croaker, white trout, spanish mackerel and king mackerel.

Sensory evaluation panel can be a precise tool for ascertaining the quality of fish if tests are designed properly and trained personnel are selected, the results being subjected to meaningful statistical analysis (Kramer, 1952). Shewan *et al.* (1953), Farber (1965) and Mammen (1966) have developed a numerical scoring system for the assessment of freshness. Krishnan (1986) has given a detailed method of assessment of frozen shrimp by organoleptic evaluation. Montgomery *et al.* (1970) and Cheuk *et al.* (1979) assessed the acceptability of ice-stored prawns and shrimps by odour and other tests. According to Cheuk *et al.*(1979) good quality was retained upto 10 days of iced storage. But Angel *et*

al.(1981) detected spoilage after 14 days of iced storage of prawn. Alvarez and Koberger (1979) reported that objectionable odours developed after 11 days storage on ice and Vanderzant *et al.*(1970) found that half of the shrimp became unacceptable after 7-14 days on ice. Cobb *et al.* (1976) found that spoilage odours were evident after 11-15 days of iced storage. Iyer *et al.*(1969) found out from the flavour score that peeled and deveined prawns can be preserved for a maximum period of 5-6 days irrespective of species, while whole and headless for 4-5 days and 6-7 days respectively. According to Pedraja (1970) in post-mortem shrimp the action of shrimp muscle enzymes, direct microbial action, bacterial enzymes and the interaction of the substances formed by these reactions causes defects like formation of malodourous substances; flavour deterioration; toughness; mushiness; juiciness; dryness and discolouration.

Utilization of *M.rosenbergii*, cultured in Hawaii, was confronted with a texture problem due to the deterioration of the edible portion during storage under ice-chilled or refrigerated condition (Nip *et al.*, 1981); the texture of the cooked prawn meat becomes mushy and is undesirable as a protein food. They found that unusual features existed in the amino acid composition of the insoluble collagen of the prawn meat. The lack of hydroxylysine together with a low content of glycine was assumed to have some effect on the textural property of the prawn meat. Nip *et al.* (1985 b) found that the conversion of the insoluble collagen to soluble collagen during the period of ice chilling leads to the degradation of the prawn abdominal tissue, and after 3 days of iced storage, mushiness was detected. They found that mushiness of the prawn could be reduced by 20% as a result of

purging. Kimura and Tanaka (1986) found that the body collagen of giant river prawn is mainly distributed in the muscle tissue. They also found that the mushiness problem of the cooked meat of the giant river prawn is not due to the unusual amino acid composition of the prawn collagen. Also the composition is similar to that of spiny lobster and fleshy prawn *Penaeus chinensis*. Angel *et al.*(1985) found that the development of mushiness in *M.rosenbergii* during iced storage differed according to the source of the raw material. It is possible that differences in the condition of the prawns, which might be related to aquaculture practices, could have influenced stress during growth and at harvest. Textural changes in a muscle food are likely to be connected with changes in protein. However, an artificial inoculation of sterile muscle with markedly proteolytic strains of *Pseudomonas* and *Flavobacterium* isolated from ice stored prawns failed to induce textural changes (Juven, 1985.). They state that mushiness development primarily in the segments closest to the cephalothorax, leads to the assumption that bacteria were not responsible for the onset of mushiness in the prawn tail. In a preliminary biochemical study no proteolytic endogenous enzymatic activity was detected in the prawn tail. They also found that the correlations between compression force measurements and panel scores were found to be low. Peleg (1983) indicated that instrumental methods of measuring texture of solid foods might incorporate ambiguities due to dimensional effects, and panel scores might be ambiguous due to semantic problems. But both the panel scores and compression forces yielded valuable information as to the onset of mushiness in ice stored prawns. Premaratne

et al. (1986) found that collagenolytic and proteolytic bacteria did not reach a high percentage until after 6 days of storage and so significant bacterial degradation of tissue cannot be expected during first 2-3 days of iced storage which is the time of onset of mushiness. Ice stored *M.rosenbergii* showed loosening of shells on the 6 th day of storage which indicates spoilage, the sensory ratings also showing spoilage at 6-8 days of storage (Joseph *et al.*, 1992).

Bieler *et al.* (1972) showed that the edible portion of the shrimp stored with heads-on maintained similar bacterial counts and sensory quality as those of shrimps stored with heads-off. Alvarez and Kourger (1979) also supported this view, their sensory panel data revealing no differences in acceptability between shrimp tails stored with or without heads and those delay headed. They had done the sensory evaluation using a 20-member panel. A 9 point hedonic scale was used. Panellists analysed the shrimp for odour, colour, texture, flavour and general acceptability on the first, sixth and eleventh day of storage. Koburger *et al.* (1974) also found that a taste panel of 15 members could not detect any difference in flavour, texture or overall acceptability between shrimp stored with or without heads throughout the iced storage period of 14 days.

Nip *et al.* (1985a) found that purging can improve the appearance of the prawn by decreasing the presence of black vein in tail and head from 82% presence in the control group to 47% in the purged group.Edmunds and Lillard (1979) reported that cultured shrimp were judged as good or better than the wild shrimp. Chen *et al.* (1990) found that during transportation of live prawns the sensory score for overall acceptability decreased

from 8.9 to 8.6 during 26 hours and iced prawns showed a decrease in acceptability score from 8.9 to 7.7 during 26 hours of iced storage.

MATERIAL AND METHODS

III MATERIAL AND METHODS

3.1 Raw material

Raw material (*Macrobrachium rosenbergii* specimen) used for the study was collected from M/S Pookot Fisheries,Trichur., M/S Aquaplaza,Cherai,Cochin and also from culture ponds of College of Fisheries, Panangad. Adult prawns with an average weight of 75 g were used for the study.

3.1.1 Transportation of the prawns.

The prawns were transported in live condition from the farms in a pickup van. The prawns were placed in large polythene bags with sufficient quantity of freshwater. The bags were filled with oxygen and sealed. The polythene bags were placed in plastic trays to protect the bags.

3.1.2 Maintenance of the prawns in live condition.

The prawns were maintained in large semi-cylindrical fibre glass tanks of 5000 litre capacity (Fig.1) with continuous aeration and fed with clam meat at a rate of 5 to 10 % of body weight twice daily. Mud was maintained at the bottom.

3.1.3.Purging of the prawns.

The prawns were divided into 2 lots as shown in the flow diagram, (Fig.2) one lot for the study on "headless shellon" product style and the other for the study on "headon" product style. First lot (for headless shellon study) was again divided into 3 lots; one lot was maintained as control and the other lot was purged for 5 hrs in running water. Here the

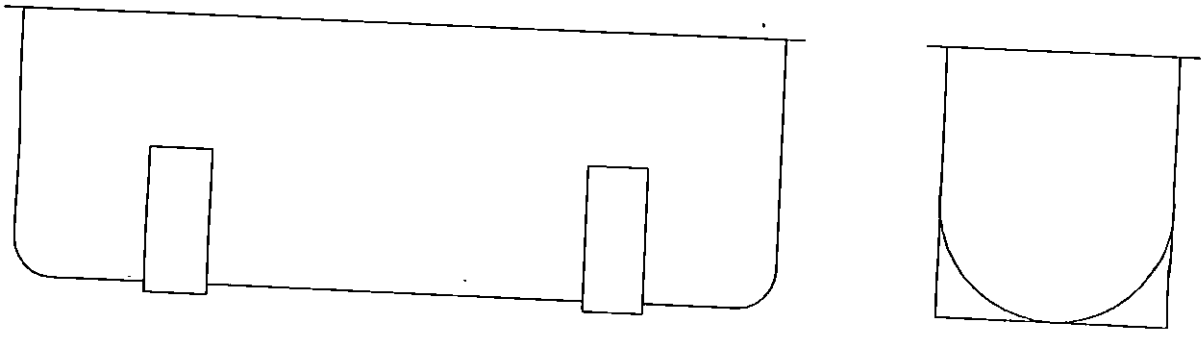

Fig.1 Figure of the semi-cylindrical tank used for maintaining the prawns

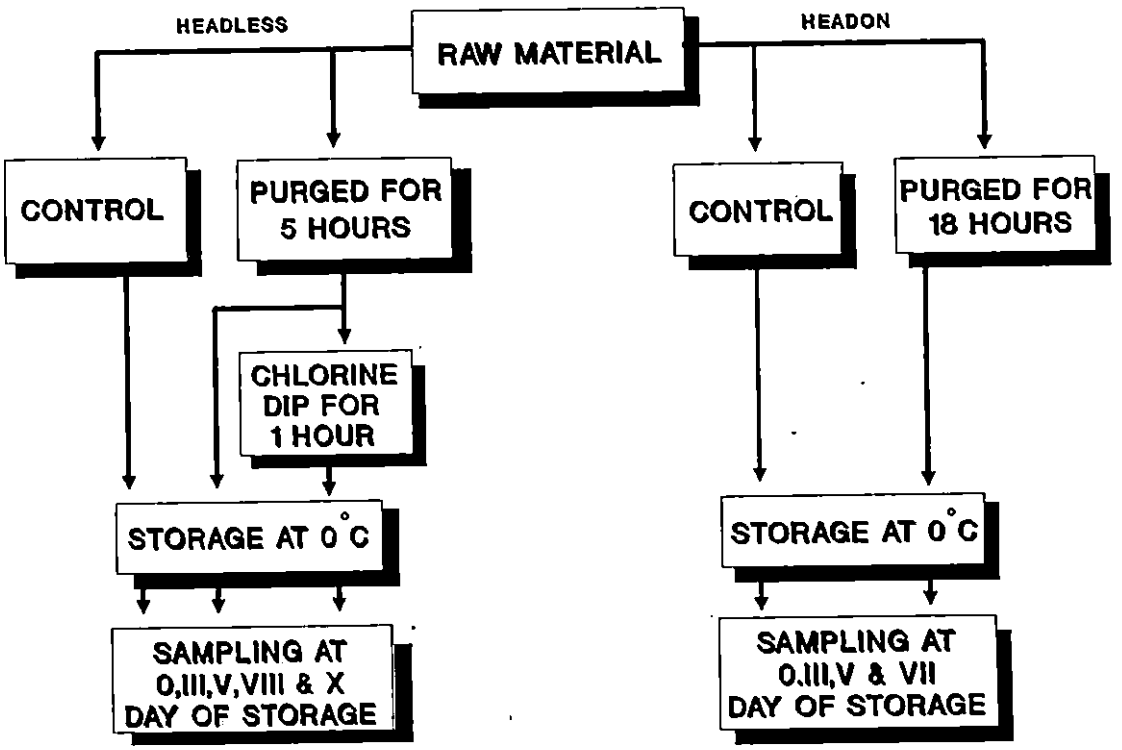

Fig.2 Flowchart of the experiment

purging was done in a cylindro-conical fibre glass tank (Fig.3). This sample was divided into two lots; one lot was killed immediately by dipping in an ice - water slurry, and the other lot was killed in the same manner after a 1 hour dip in 1 ppm chlorinated water. All the lots were then stored in a refrigerator with 1:1 icing. Samples were drawn at 0,3,5,8 and 10^{th} days of iced storage.

The second lot was used for the study on headon product style. The animals were maintained in semi-cylindrical fibreglass tanks of 5000 litre capacity with mud at the bottom. The test lot was taken from this tank and was maintained in a cylindro-conical fibreglass (Fig.4) tank of 5000 litre capacity with continuous flow of freshwater for 18 hrs, for purging. After purging the prawns were killed atonce by dipping in an ice-water slurry. The other lot which was not purged was the control and the prawns were killed in the same manner. Then the specimen were stored in a refrigerator with 1:1 icing. Samples were drawn at 0,3,5 and 7^{th} days of iced storage.For the chemical analysis 3 samples were drawn for each experiment and for the sensory evaluation 10 samples were used for each evaluation.

3.2 Iced storage

All the samples were stored in a refrigerator at +1°C in plastic boxes with 1:1 icing. The ice was replenished daily.

3.3 Determination of total volatile bases

Determination of TVB (Conway 1947) was employed as a test for prawns spoilage. In this method, ammonia and other aliphatic amines in the prawns were

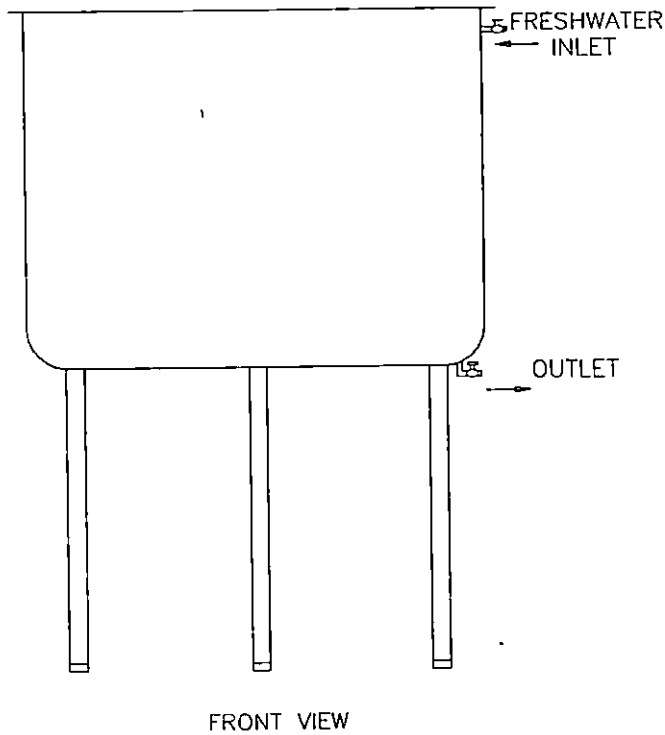

Fig.3 Figure of the cylindrical tank used for purging prawns for 5 hours

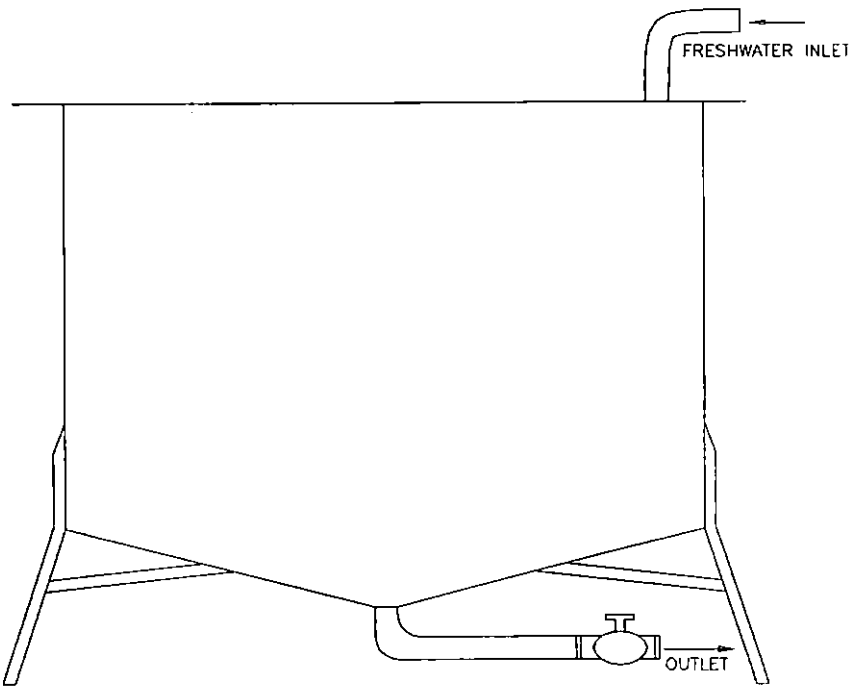

Fig.4 Figure of cylindro-conical tank used for purging prawns for 18 hours.

determined.

A TCA extract of the prawn was prepared. From the TCA extract, TVB was liberated with alkali and the liberated TVB was absorbed in standard acid in a Conway's microdiffusion unit. From the amount of acid consumed, TVB content could be calculated.

TCA extract was prepared first. For this 8 g of the tissue was blended in a mortar with 12 ml 30 % TCA and 40 ml distilled water. The extract was filtered through a filter paper and the filterate was made upto 50 ml using 5 % TCA.1 ml of N / 50 H_2SO_4 was taken in the inner chamber of the Conway's microdiffusion unit. Added 1 ml of the TCA extract and 1 ml of saturated Na_2CO_3 in the outer chamber. The unit was gently rotated to mix the contents, sealed with the glass lid and was kept undisturbed overnight. Then the lid was removed and 1 drop of Taschiro's indicator was added to the inner chamber. The amount of unreacted acid was determined by titrating against N / 50 NaOH.

3.4 Determination of alpha amino nitrogen

Alpha amino nitrogen was determined by the method of Pope and Stevens (1939). This method is based on the formation of a soluble copper complex through the reaction between aminoacid and excess copper in the form of copper sulphate. The amount of copper taken into solution by amino acid was determined separately.

Here the TCA extract was prepared as described above in TVB determination. 20 ml of this extract was taken in a 50 ml standard flask. Added 2 drops of thymolphthalein

indicator followed by 10 N sodium hydroxide drop by drop till a faint blue colour was obtained. Made up the volume to 50 ml using cupric phosphate suspension, mixed and allowed to stand for 30 minutes. Filtered through a Whatman No.1 filter paper. Pipetted 10 ml of the filtrate into a conical flask, added 2.0 g KI and 1 ml Glacial acetic acid and titrated immediately against 0.01 N Sodium thiosulphate using starch as indicator till the blue colour was completely discharged. The content of alpha amino nitrogen was calculated from the relation 1 ml of 0.01 N sodium thiosulphate is equivalent to 0.28 mg of alpha amino nitrogen.

3.5 Determination of non protein nitrogen

The NPN was determined by the method described in A.O.A.C.1975. TCA extract of the sample was taken so that it was free of protein nitrogen. This was oxidised by sulphuric acid to form CO_2 and water and release the nitrogen as ammonia. The ammonia exists in sulphuric acid as ammonium sulphate. Digestion mixture was used to accelerate the digestion. The ammonia thus formed was trapped in a known quantity of standard acid. The acid was then back titrated to determine the amount of ammonia distilled.

10 ml of the TCA extract was taken in a Kjeldahl's flask. Added 10 ml conc. H_2SO_4 and a speck of digestion mixture. Heated gently until frothing ceased. Boiled till the solution was clear and continued the boiling for another 30 minutes. Cooled and added distilled water till no effervescence was produced. Made up the solution to 100 ml. An aliquot of 10 ml was used for distillation and estimation of the liberated ammonia by

Kjeldahl's distillation unit.

3.6 Determination of acid insoluble ash

Acid insoluble ash was determined according to the Indian Standards Institution method (IS.8353 1966). Weighed 5 g of dried sample in a silica dish, ignited for 1 hr, placed in a muffle furnace at 600°C until grey ash. Cooled and added 35 ml 1:1 HCl, covered with watch glass and heated on a water bath for 10 minutes. Cooled and filtered through a Whatman No. 42 filter paper. Washed the residue with hot water until washings were free of chloride (as titrated against Ag NO_3 solution). Returned the filter paper with residue to the crucible. Kept in a hot air oven at 135°C for 3 hrs. Ignited in a muffle furnace at 600°C for 1 hr. Cooled in a dessicator and weighed. Ignited again for 30 minutes cooled and weighed. Repeated for concordant weight.

3.7 Determination of muscle pH

5 g of the prawn meat was blended with 5 ml of water and pH of the blend was measured using a pH meter by immersing the electrode well inside the blend. The instrument was set using a standard buffer of pH 8.2. The pH meter used was Elico digital pH meter.

3.8 Sensory evaluation

The sensory evaluation was done by a panel of 10 judges (Judith 1973). The samples were coded and presented to the judges. The judges evaluated the quality of the raw samples for colour / appearance by visual feel, texture by finger feel, aroma by

olfaction. The quality of the cooked samples were evaluated for colour by visual feel, aroma by olfaction, flavour / taste by tongue and olfaction. All the sensory feel ratings were recorded in a score sheet and the ratings are based on previously assigned numerical scores.

3.9 Statistical analysis

Statisical analysis was done using randomized block design

3.10 Chemicals

All the chemicals used in the study were either AR or GR grades.

RESULTS

IV RESULTS

4.1 Chemical evaluation of headless prawns

The chemical evaluation done were Alpha Amino Nitrogen, Total Volatile Bases, Non Protein Nitrogen, Acid Insoluble Ash and pH.

4.1.1 Alpha amino nitrogen of headless prawns.

For the Control the alpha amino nitrogen content was 348.0982 ± 1.9729 mg N / 100 g of meat on the initial day. By the third day of storage the quantity had risen to 349.0481 ± 3.8635 mg N / 100 g. of meat. From the fifth day to eighth day it was more or less steady and on the 10 th day of storage it was 301.5492 ± 0.8972 mg N / 100 g. of meat.

In the case of the purged prawn a similar type of change was seen. While on the initial day the alpha amino nitrogen content was 351.0235 ± 6.0865 mg N / 100 g. of meat, by the third day it increased to 355.8255 ± 2.9920 and on the final day of storage it was 300.9142 ± 3.6990 mg N / 100 g. of meat.

In the case of the purged chlorine dipped prawn an alpha amino nitrogen content of 440.8091 ± 13.4812 mg N / 100 g of meat was seen on the initial day, which increased to 442.4801 ± 11.2995 on the third day of storage and steadily declined to 358.8529 ± 19.8728 mg N / 100 g. of meat by the 10 th day of storage.

The trend is shown in Fig. 5. The results of statistical analysis is provided in the Table 1. The statistical analysis shows a significant difference at 5% level of significance

between the control and the chlorine treated sample and there is no significant difference between the control and purged prawns.

4.1.2 Total volatile bases of headless prawns.

The TVB at first shows an increase upto the third day of storage in both the control and purged - chlorine dipped prawns i.e. from an initial TVB content of 22.6519 ± 0.7450 mg N / 100 g of meat and 23.4815 ± 1.2142 mg N / 100 g of meat to 25.5191 ± 0.8395 mg N / 100 g of meat and 28.4170 ± 0.7728 mg / 100 g meat respectively. In the case of the purged prawns, the peak was shown on the 5 th day of storage from 23.0539 ± 1.3445 mg N / 100 g of meat to 25.1147 ± 1.5524 mg N / 100 g of meat. The TVB content then showed a decline to 21.3408 ± 0.3773, 19.4716 ± 1.1589, 20.2869 ± 1.63651 mg N / 100 g of meat by the final day of iced storage for the control, purged and the purged - chlorine dipped sample.

These results are shown in the Fig.6. The statistical analysis shown in the Table 2, shows significant variation between the control and the two treatments.

4.1.3 Non protein nitrogen of headless prawns.

During the initial day of storage the NPN content of the control, purged and purged - chlorine dipped prawn were 0.4530 ± 0.0075, 0.4892 ± 0.0088 and 0.5215 ± 0.0205 g N / 100 g of meat. On the third day it changed to 0.4426 ± 0.0134, 0.54309 ± 0.0149 and 0.6330 ± 0.0084 and by the 10^{th} day of storage it was reduced to 0.3121 ± 0.0085, 0.3879

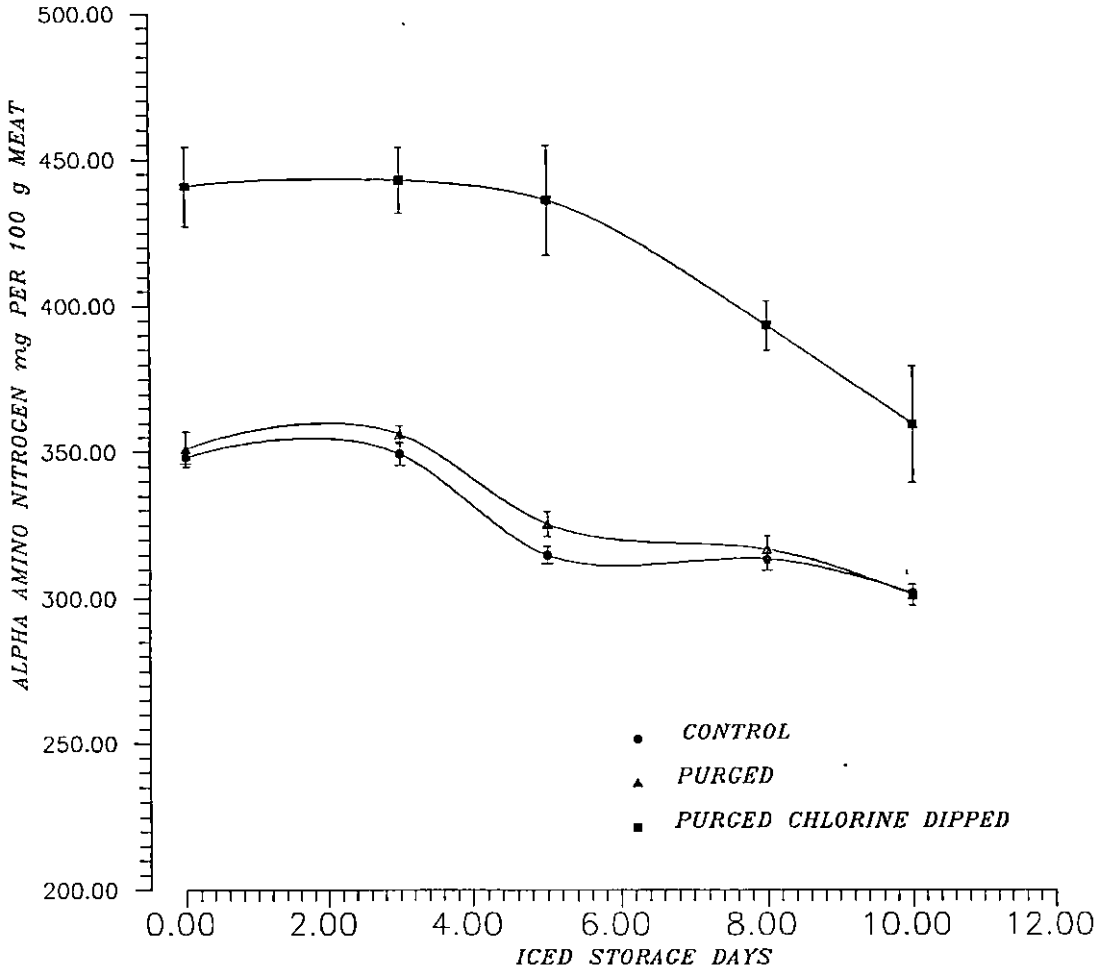

Fig.5 Variation of alpha amino nitrogen in headless prawns during iced storage

Table 1. Analysis of variance for alpha amino nitrogen in headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	74892.84	37446.42	295.9149*
BETWEEN DAYS	4	24995.05	6248.764	49.3800
INTERACTION	10	3688.773	368.8773	2.9150
BETWEEN CELLS	14	103576.7	7398.333	58.4643
ERROR	30	3796.336	126.5445	
TOTAL	44	107373	t (5%) = 2.042	

* significant difference between the treatments

Pairwise comparison

Control[a]

Purged[b]

Purged-Cl dipped[b]

Treatment with different superscripts show significant variation.

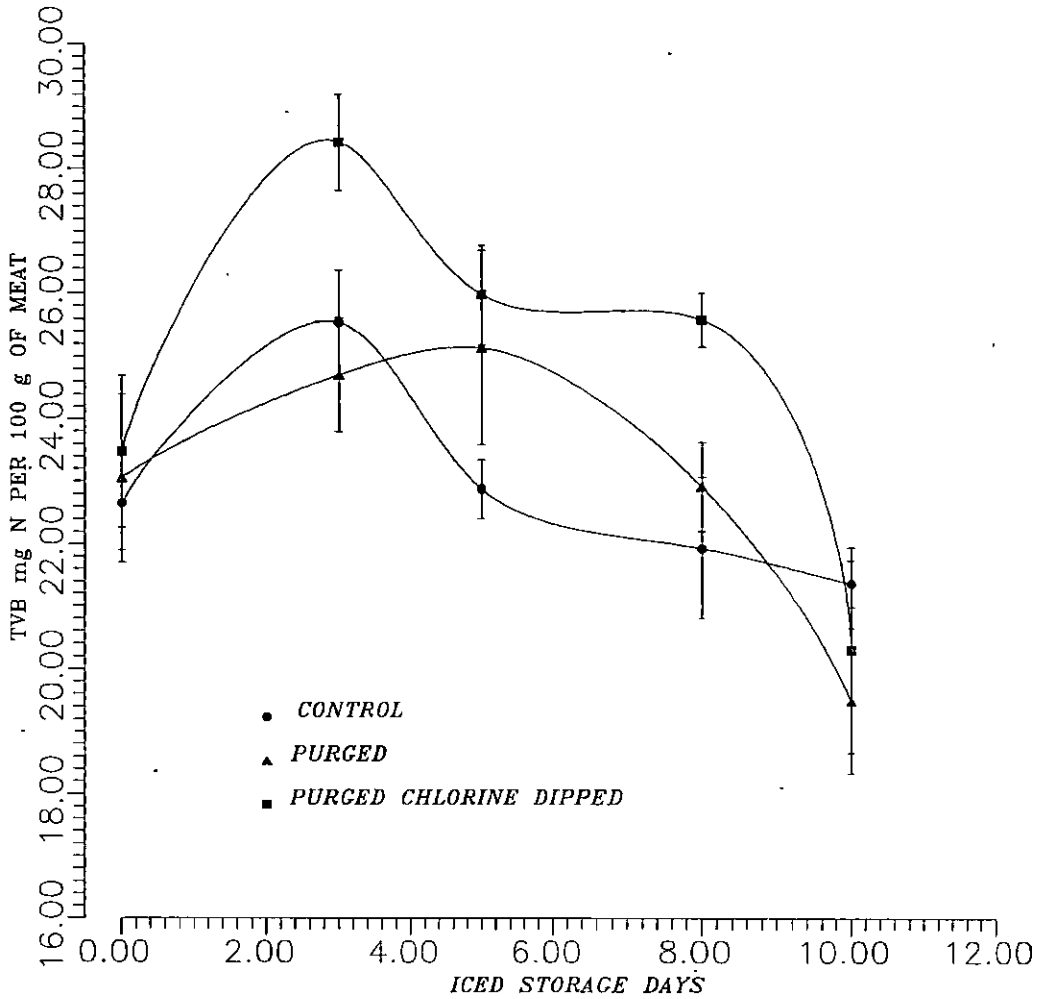

Fig. 6 Variation of total volatile bases in headless prawns during iced storage

Table 2. Analysis of variance for total volatile base in headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	32.2035	16.1018	10.4919*
BETWEEN DAYS	4	167.8587	41.9647	27.3443
INTERACTION	10	33.6513	3.3651	2.1927
BETWEEN CELLS	14	233.7135	16.6938	10.8777
ERROR	30	46.0404	1.5347	
TOTAL	44	279.7539	t (5%) = 2.0420	

* significant difference between the treatments

Pairwise comparison

Control[a]

Purged[b]

Purged-Cl dipped[b]

Treatment with different superscripts show significant variation.

$\pm$ 0.0090 and 0.4464 $\pm$ 0.0069 g N /100 g of meat respectively. This is shown in the Fig. 7.The statistical analysis is shown in the Table 3. The analysis shows no significant difference between the control and the purged sample while there is significant difference between the control and the purged - chlorine dipped sample.

4.1.4 pH of headless prawns.

All the treatments are showing an acidic pH during the initial day of storage. The values were 6.5200 $\pm$ 0.0245, 6.4967 $\pm$ 0.0369 and 6.6600 $\pm$ 0.0374 for the control, purged and purged - chlorine dipped prawn, and increased to a peak of 8.5000 $\pm$ 0.0408 and 8.5400 $\pm$ 0.0327 for the control and purged - chlorine dipped samples during the 8^{th} day of storage and then decreased to 8.4100 $\pm$ 0.0497 and 8.5133 $\pm$ 0.0263 on the 10^{th} day of storage. For the purged sample the peak of 8.5633 $\pm$ 0.0201 was shown on the 10^{th} day of storage. These are shown in the Fig.8.

Statistical analysis shows that there is significant difference between the control and the purged - chlorine dipped sample and no significant difference between the control and the purged sample (Table 4).

4.1.5 Acid insoluble ash of headless prawns.

Acid insoluble ash did not show any statistically significant variation either between treatments or between days.On the initial day the acid insoluble ash content were 0.0153 $\pm$ 0.0045, 0.0153 $\pm$ 0.0027 and 0.0161 $\pm$ 0.0027 % of meat for the control, purged

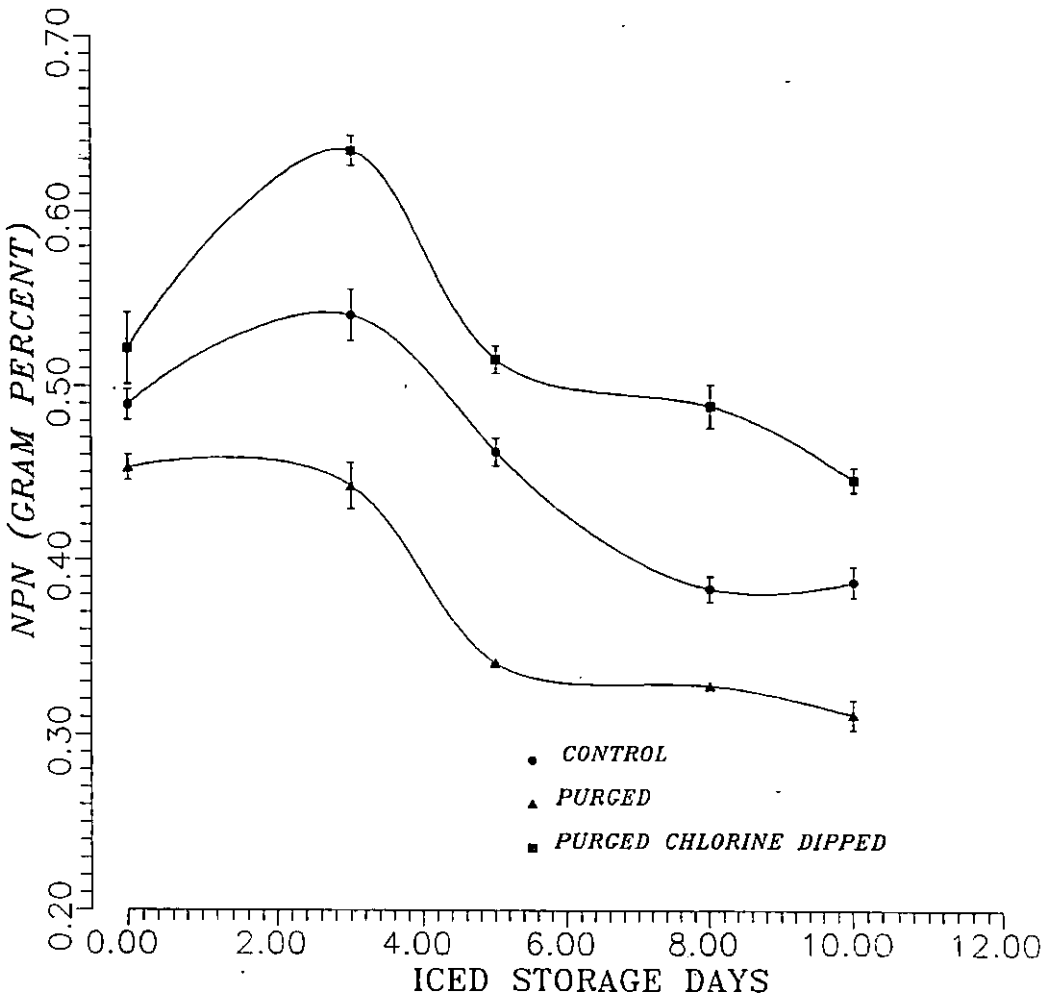

Fig. 7 Variation of non protein nitrogen in headless prawns during iced storage

Table 3. Analysis of variance for non protein nitrogen in headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	0.1599	0.0799	510.9982*
BETWEEN DAYS	4	0.1496	0.0374	238.9902
INTERACTION	10	0.0175	0.0017	11.1765
BETWEEN CELLS	14	0.3269	0.0234	149.2587
ERROR	30	0.0047	0.0002	
TOTAL	44	0.3316	t (5%) = 2.0420	

* significant difference between the treatments

Pairwise comparison

Control[a]

Purged[b]

Purged-Cl dipped[b]

Treatment with different superscripts show significant variation.

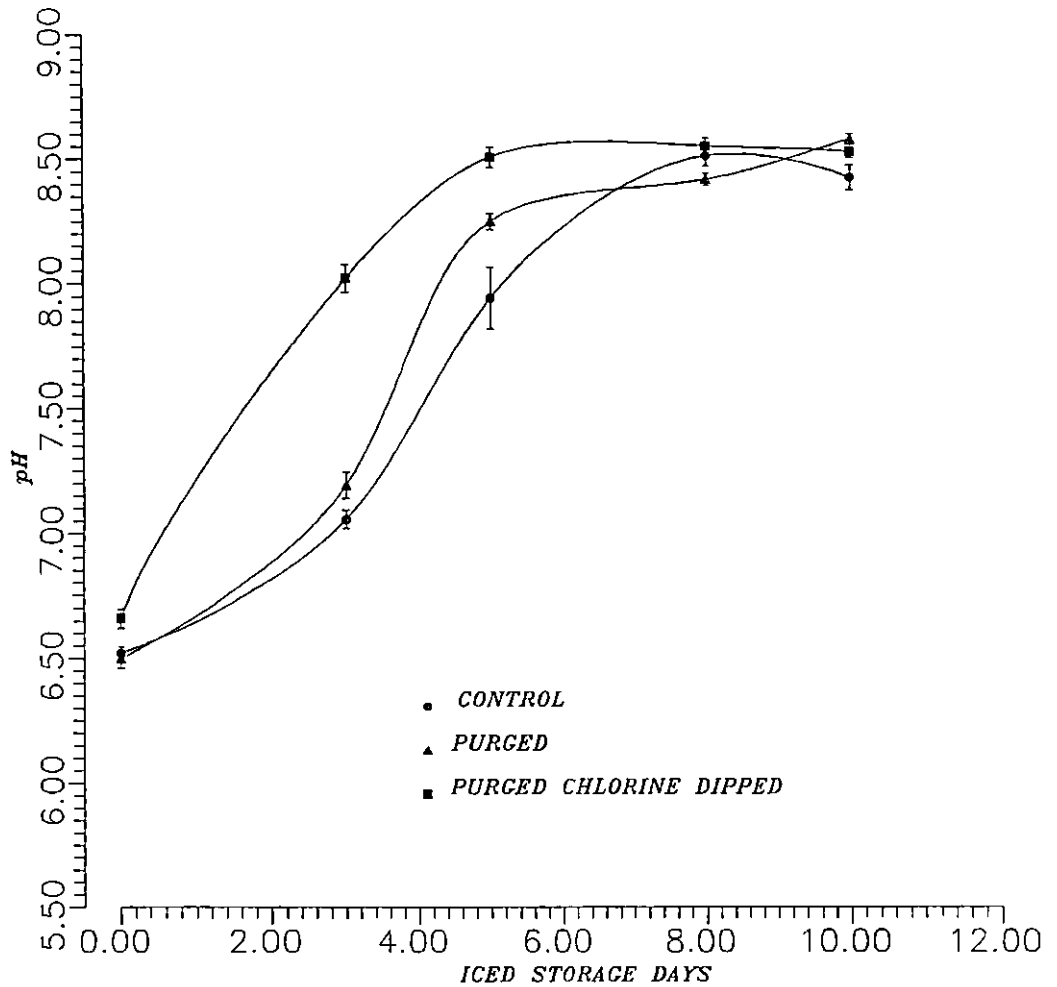

Fig. 8 Variation of pH in headless prawns during iced storage

Table 4. Analysis of variance for pH in headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	1.0551	0.5276	151.2303*
BETWEEN DAYS	4	25.2838	6.3209	1811.949
INTERACTION	10	1.1641	0.1164	33.3702
BETWEEN CELLS	14	27.5030	1.9645	563.1400
ERROR	30	0.1047	0.0035	
TOTAL	44	27.6077	t(5%) =	2.0420

* significant difference between the treatments

Pairwise comparison

Control[a]

Purged[b]

Purged-Cl dipped[b]

Treatment with different superscripts show significant variation.

and purged - chlorine dipped sample. On the final day the acid insoluble ash content were 0.0182 ± 0.0053, 0.0179 ± 0.0027 and 0.0151 ± 0.0020 respectively.

The ANOVA is shown in the Table 5 and the trend in the Fig. 9

4.2 Sensory evaluation of headless prawns

A taste panel of ten panelists were made for the sensory evaluation. Sensory evaluation was done for both the raw and cooked prawn. The sample of the score sheet is given in the appendix.

4.2.1 Sensory evaluation of raw headless prawns.

Raw samples were presented before the ten taste panel members to evaluate the sensory attributes like Appearance, Odour and Texture according to the score given in the score sheet.

4.2.1.1 Appearance of raw headless prawns.

On the initial day the Appearance scores were 8.8889 ± 1.3699, 8.0000 ± 1.3333 and 8.4444 ± 1.5713 for the control, purged and purged - chlorine dipped. During the storage days a steady decline in the score was shown and by the final day the scores were 4.6667 ± 0.9428, 3.5556 ± 2.0608 and 3.5556 ± 2.2662 for the control, purged and purged - chlorine dipped prawn. These changes are shown in the Fig. 10.The statistical analysis shows significant difference between the control and purged - chlorine dipped prawn (Table 6).

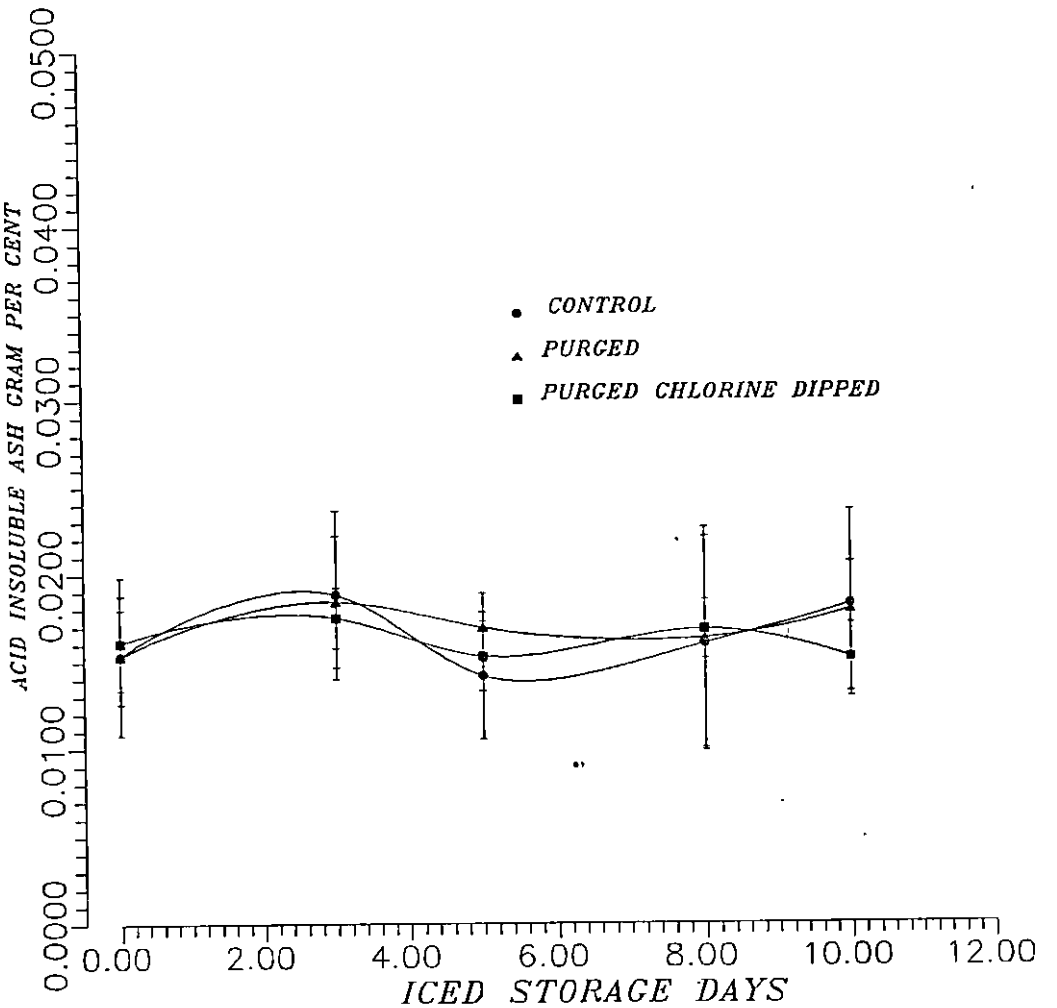

Fig. 9 Variation of acid insoluble ash in headless prawns during iced storage

Table 5. Analysis of variance for acid insoluble ash in headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	0.000005	0.000002	0.112762
BETWEEN DAYS	4	0.000048	0.000012	0.550045
INTERACTION	10	0.000029	0.000003	0.132433
BETWEEN CELLS	14	0.000081	0.000006	0.26786
ERROR	30	0.00065	0.000022	
TOTAL	44	0.000731	t (5%) = 2.042	

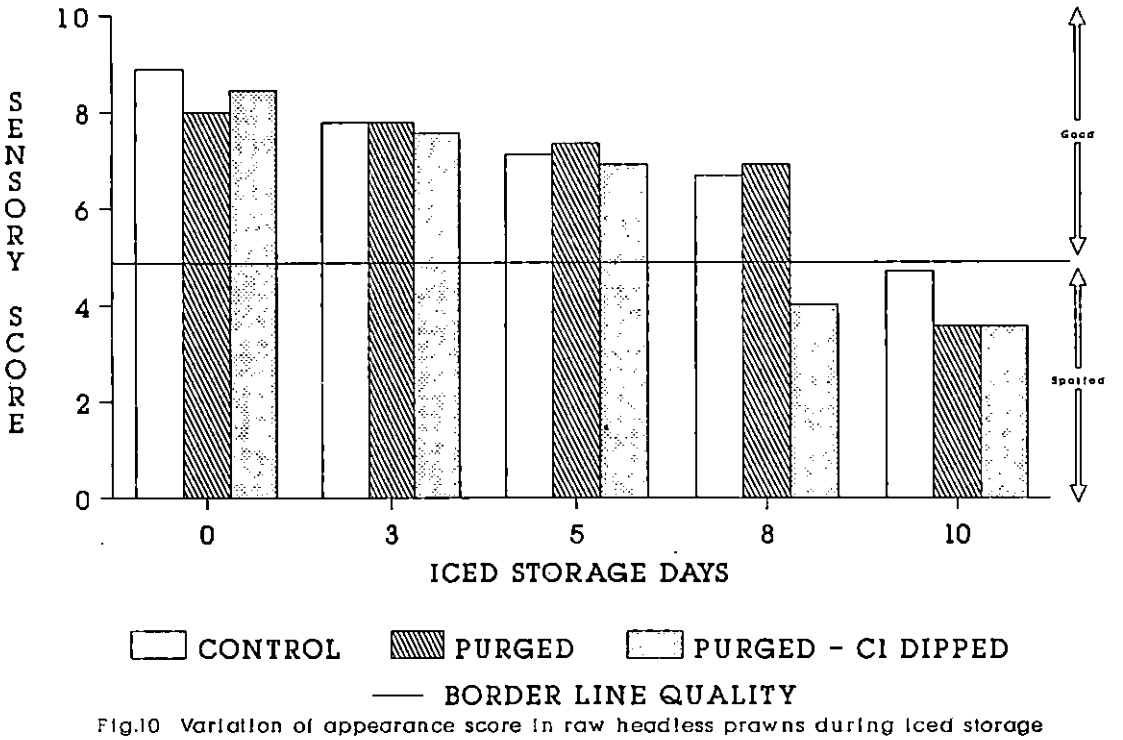

Fig.10 Variation of appearance score in raw headless prawns during iced storage

Table 6. Analysis of variance for appearance score of raw headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	20.3257	10.1629	3.0220*
BETWEEN DAYS	4	339.9702	84.9925	25.2731
INTERACTION	10	38.3410	3.8341	1.1401
BETWEEN CELLS	14	398.6368	28.4741	8.4670
ERROR	120	403.5555	3.3630	
TOTAL	134	802.1924	t (5%) = 1.9800	

* significant difference between the treatments

Pairwise comparison

Control[a]

Purged[a]

Purged-Cl dipped[b]

Treatment with different superscripts show significant variation.

4.2.1.2 Odour of raw headless prawns

The Odour scores on the initial day for the control, purged and purged - chlorine dipped prawns were 8.6667 ± 1.6330, 8.2222 ± 1.7498 and 7.6667 ± 1.8856 and on the final day it was reduced to 5.0000 ± 0.4714, 4.8889 ± 0.7370 and 4.6667 ± 0.6667 . These variations are represented in the Fig.11.

The statistical analysis shows no significant difference between the treatments and the control. This is shown in the Table 7.

4.2.1.3 Texture of raw headless prawns

On the initial day the texture scores were 10.0000, 9.5556 ± 0.8315 and 9.5556 ± 0.8315 and on the final day the scores were 7.1111 ± 0.9938, 7.1111 ± 0.9938 and 6.6667 ± 0.942 for the control, purged and purged - chlorine dipped prawns respectively. The texture score variations are shown in the Fig.12.

Statistical analysis shows no significant difference between the treatments .Table 8.

4.2.2 Sensory evaluation of cooked headless prawns.

The prawns were cooked in boiling water for 15 minutes and the sensory evaluation was done for Colour, Odour and Flavour.

4.2.2.1 Colour of cooked headless prawns.

The sensory score for Colour were 9.3333 ± 0.9428, 9.5556 ± 0.8315 and 9.7778 ± 0.6285 during the initial day and decreased to 6.8889 ± 0.9938, 6.7778 ± 1.4741 and

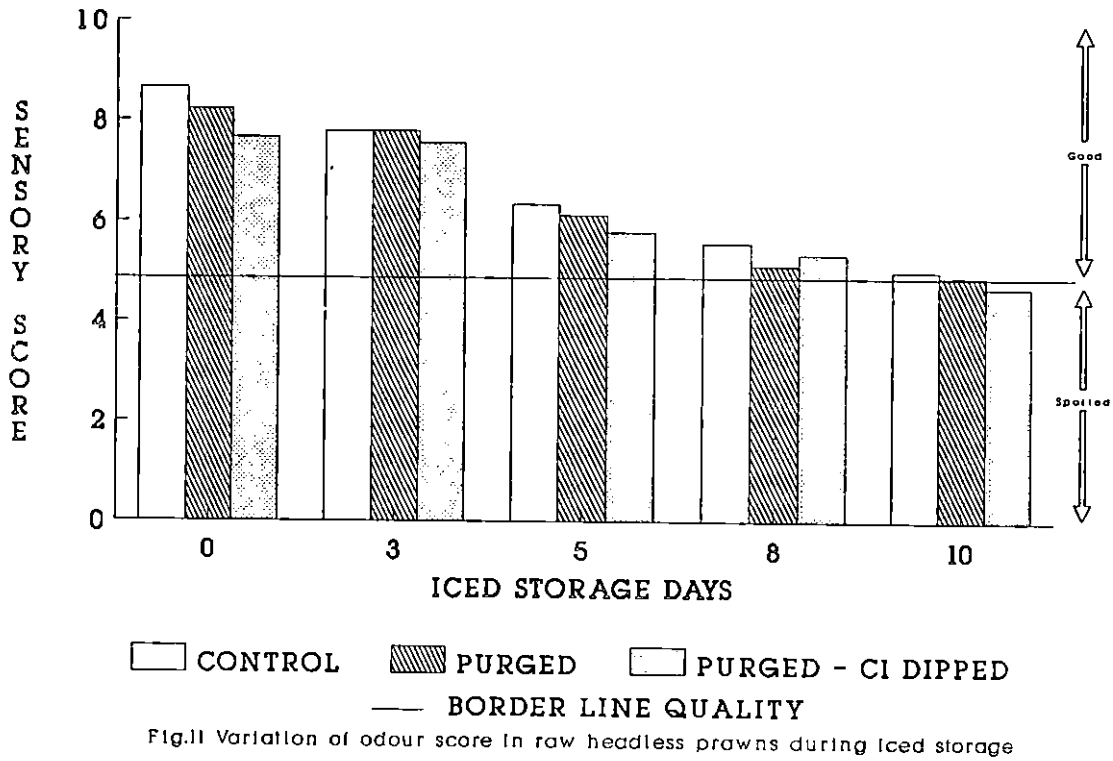

Fig.11 Variation of odour score in raw headless prawns during iced storage

Table 7. Analysis of variance for odour score of raw headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	4.9038	2.4519	1.3922
BETWEEN DAYS	4	230.1186	57.5296	32.6667
INTERACTION	10	2.7259	0.2726	0.1548
BETWEEN CELLS	14	237.7482	16.9820	9.6428
ERROR	120	211.3333	1.7611	
TOTAL	134	449.0815	t (5%) = 1.9800	

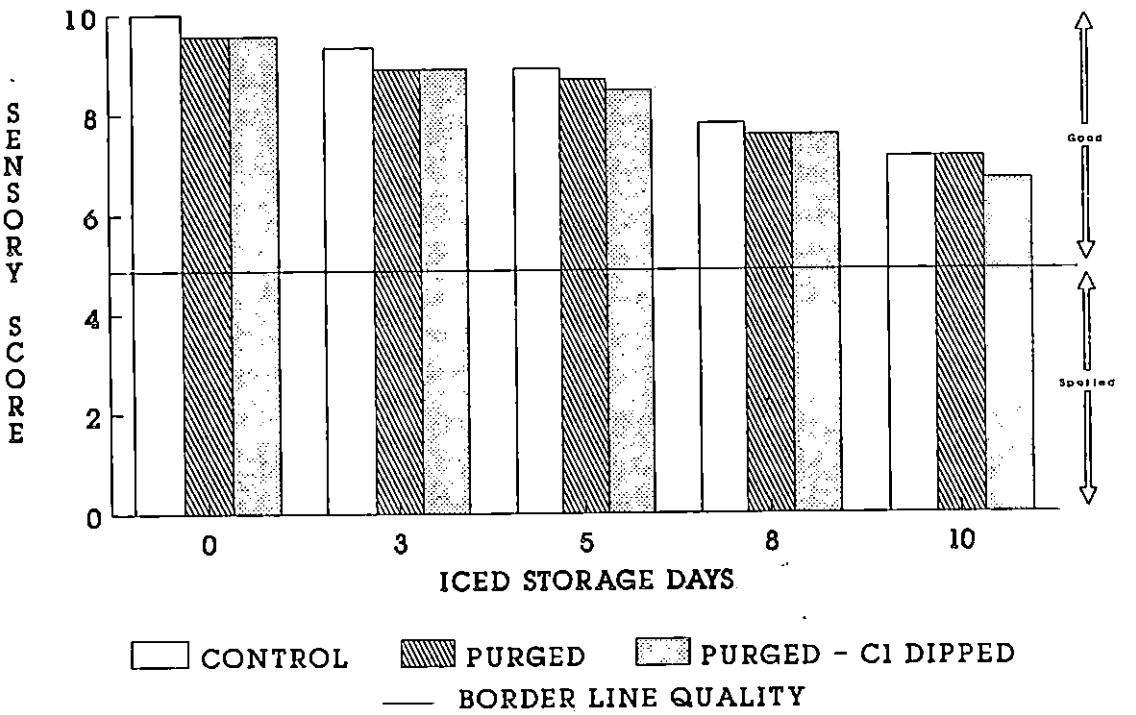

Fig.12 Variation of texture score in raw headless prawns during iced storage

Table 8. Analysis of variance for texture score of raw headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	3.7337	1.8669	1.4825
BETWEEN DAYS	4	130.5485	32.6371	25.9177
INTERACTION	10	1.0070	0.1007	0.0800
BETWEEN CELLS	14	135.2893	9.6635	7.6740
ERROR	120	151.1111	1.2593	
TOTAL	134	286.4004	t (5%) = 1.9800	

6.5556 ± 1.065 by the tenth day of storage for the control, purged and purged - chlorine dipped prawns respectively. This is shown graphically in the Fig. 13.

The statistical analysis shows no significant difference between the Colour scores of the various treatments. The statistical analysis is shown in the Table 9.

4.2.2.2 Odour of cooked headless prawns

The Odour scores for the prawns were 9.7778 ± 0.6285 and 9.7778 ± 0.6285 and 9.5556 ± 0.8315 for the control, purged and purged - chlorine dipped prawns during the initial day and on the final day of storage it was 6.5556 ± 1.9500, 6.6667 ± 0.9428 and 7.1111 ± 0.9938. These are shown in the Fig. 14.

The statistical analysis shows no significant difference between the control and treatments.The results are shown in the Table 10.

4.2.2.3 Flavour of cooked headless prawns.

The Flavour variations during the 10 days of storage are shown in the Fig. 15. On the initial day the Flavour scores were 9.7778 ± 0.6285, 9.7778 ± 0.6285 and 9.5556 ± 0.8315 and on the final day of storage the Flavour scores were 5.7778 ± 1.0304, 5.7778 ± 1.8725 and 5.5556 ± 0.496 for the control, purged and purged - chlorine dipped prawns respectively.

The statistical analysis shown in the Table 11 shows no significant difference between the control and treatments.

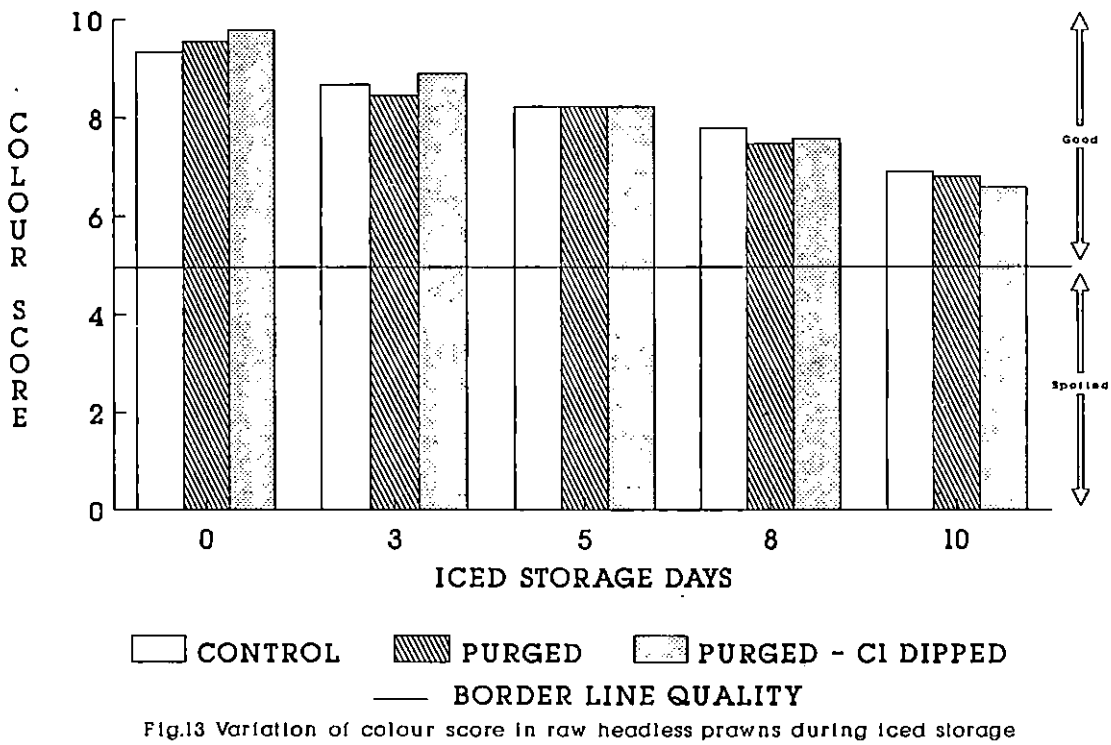

Fig.13 Variation of colour score in raw headless prawns during iced storage

Table 9. Analysis of variance for colour score of raw headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	0.3112	0.1556	0.1072
BETWEEN DAYS	4	122.6964	30.6741	21.1276
INTERACTION	10	2.5036	0.2504	0.1724
BETWEEN CELLS	14	125.5112	8.9651	6.1749
ERROR	120	174.2222	1.4519	
TOTAL	134	299.7334	t (5%) = 1.9800	

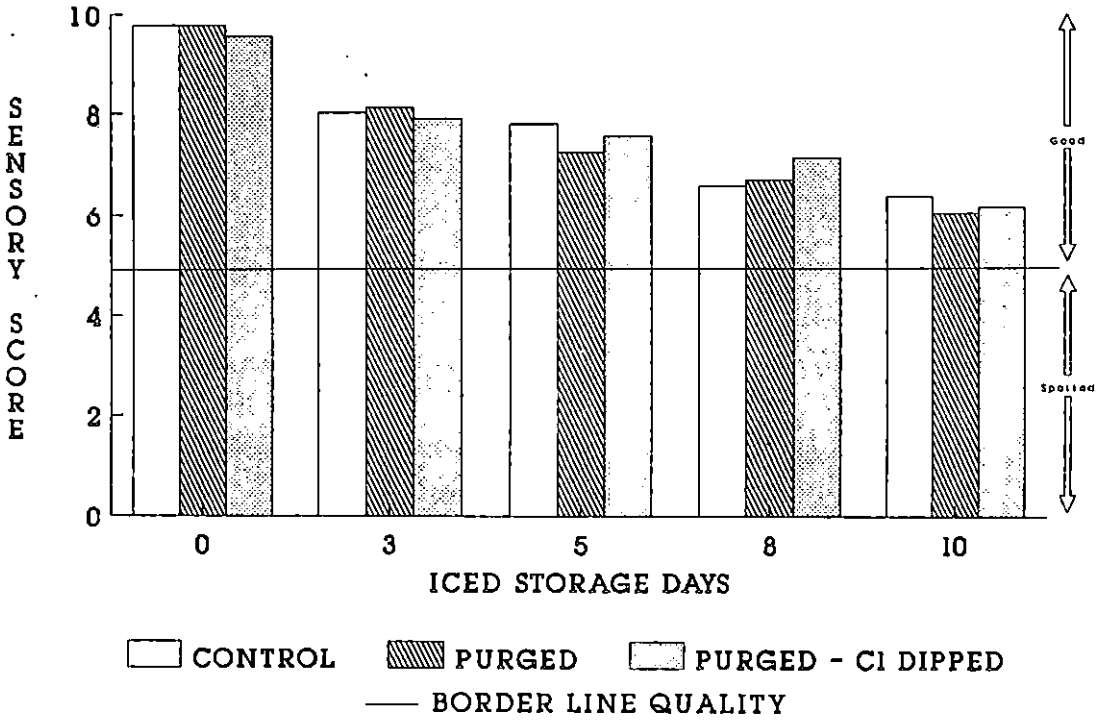

Fig.14 Variation of odour score in cooked headless prawns during iced storage

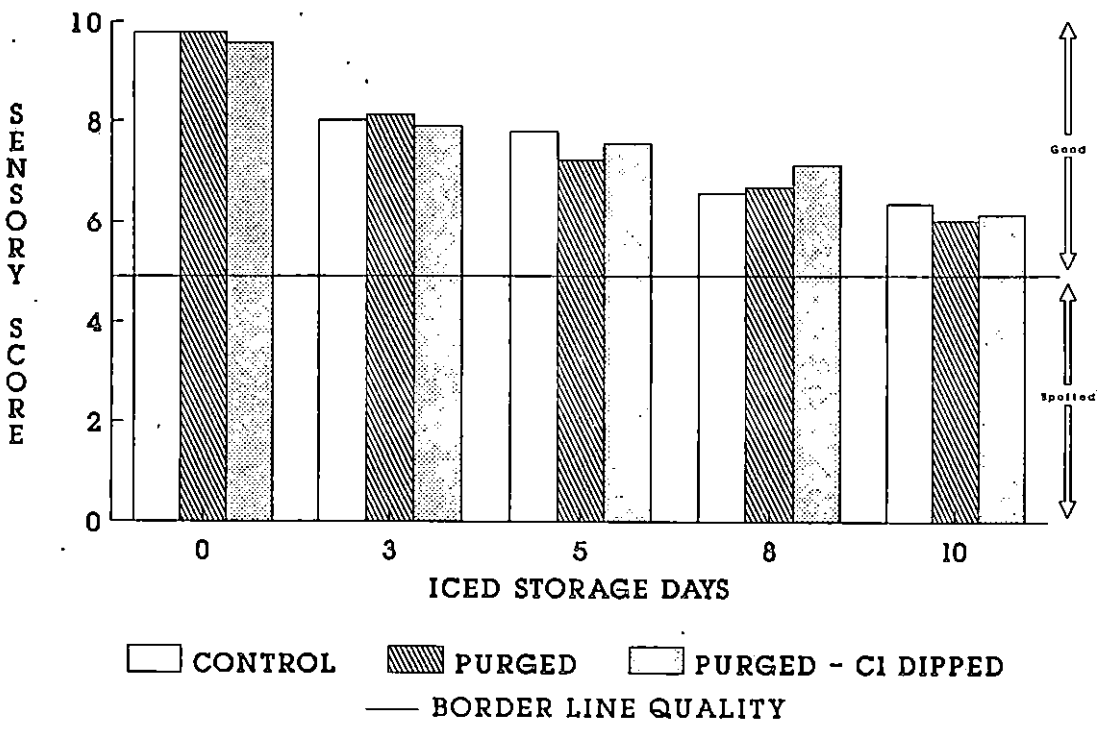

Fig.14 Variation of odour score in cooked headless prawns during iced storage

Table 10. Analysis of variance for odour score of cooked headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	0.4148	0.2074	0.1217
BETWEEN DAYS	4	199.0370	49.7593	29.2065
INTERACTION	10	3.5852	0.3585	0.2104
BETWEEN CELLS	14	203.0370	14.5026	8.5124
ERROR	120	204.4444	1.7037	
TOTAL	134	407.4814	t (5%) = 1.9800	

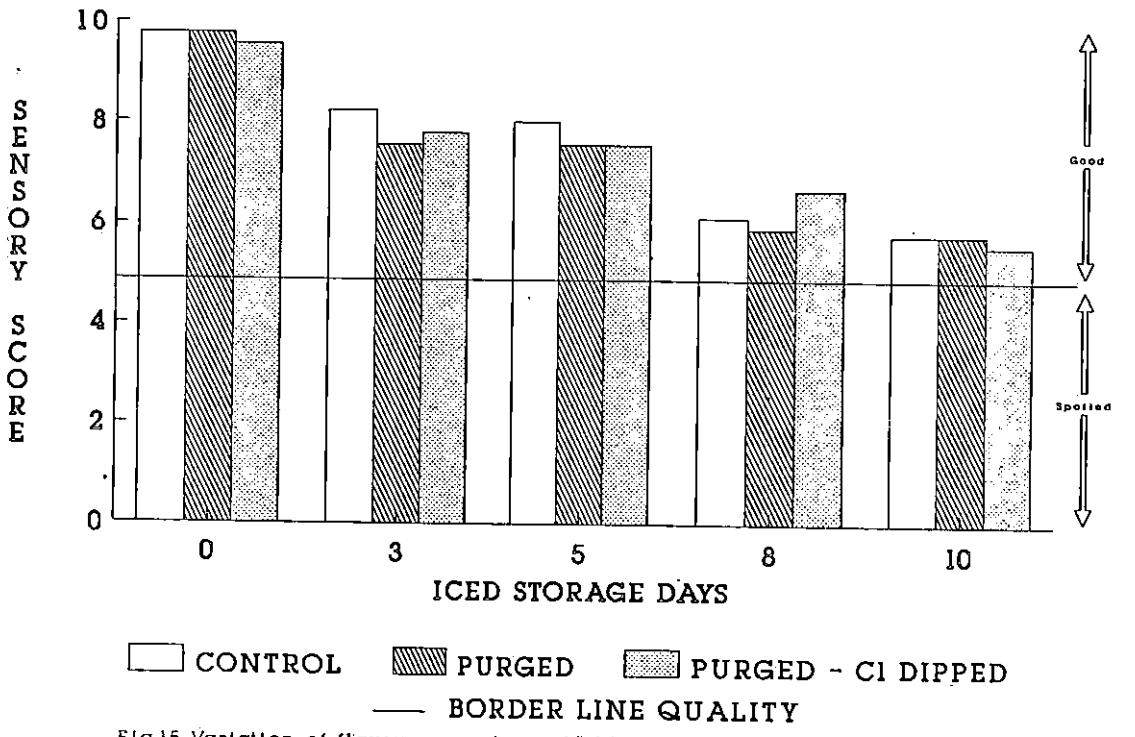

Fig.15 Variation of flavour score in cooked headless prawns during iced storage

Table 11. Analysis of variance for flavour score of headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	1.6148	0.8074	0.4888
BETWEEN DAYS	4	266.2519	66.5630	40.2960
INTERACTION	10	5.1259	0.5126	0.3103
BETWEEN CELLS	14	272.9926	19.4995	11.8046
ERROR	120	198.2222	1.6519	
TOTAL	134	471.2148	t (5%) = 1.9800	

4.2.2.4 Percentage of black vein of cooked headless prawns.

On the initial day of storage the percentage black vein content was 85.5556 ± 6.8493, 77.7778 ± 6.2854 and 78.8889 ± 7.3703 % for the control, purged and purged - chlorine dipped prawns. By the final day of storage the percentage of black vein content was 84.4444 ± 6.8494 85.5556 ± 4.9690 and 82.2222 ± 7.856 for the control, purged and purged - chlorine dipped prawns (Fig. 16).

The statistical analysis show difference between the control and treatments and there is no significant difference between the purged and the purged - chlorine dipped samples (Table 12).

4.3 Chemical evaluation of headon prawns

Here only one treatment is done viz. the purging of the prawn in running water for 15 hours in large fibreglass tanks. The chemical evaluation carried out were, the estimation of Alpha Amino Nitrogen, Total Volatile Base, Non Protein Nitrogen and pH.

4.3.1 Alpha amino nitrogen of headon prawns.

The alpha amino nitrogen content of the samples were 342.6568 ± 3.6863 mg N / 100 g. of meat for the control and 314.0774 ± 1.563 mg N / 100 g. of meat for the purged sample on the initial day and the quantity increased on the 3rd day to 416.4617 ± 4.6653 and 354.88 ± 2.44, then on the 7th day to 396.5681 ± 4.6748 and 305.8424 ± 2.8663 mg N / 100 g. of meat for the control and the purged sample. (Fig. 17).

The statistical analysis shows a significant difference between the control and the

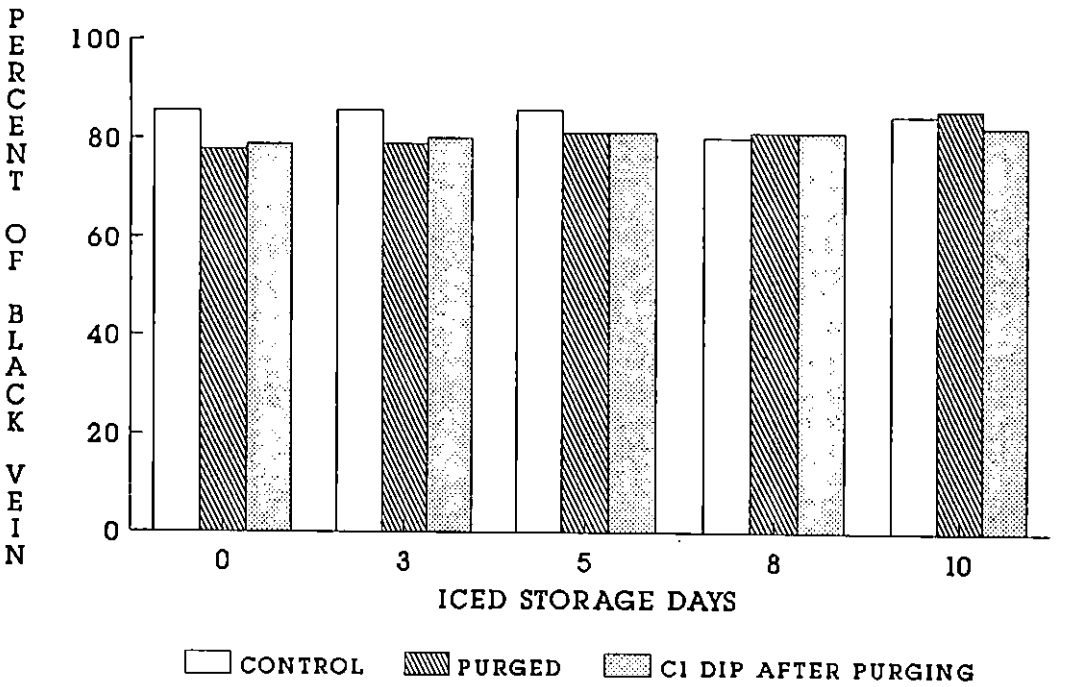

Fig.16 Variation of percentage of black vein in cooked headless prawns during iced storage

Table 12. Analysis of variance for percentage of black vein incooked headless prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	2	357.0278	178.5139	2.9937*
BETWEEN DAYS	4	217.7685	54.4421	0.9130
INTERACTION	10	368.8982	36.8898	0.6186
BETWEEN CELLS	14	943.6945	67.4068	1.1304
ERROR	120	7155.556	59.6296	
TOTAL	134	8099.25	t (5%) = 1.9800	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Purged-Cl dipped[b]

Treatment with different superscripts show significant variation.

[illegible] 7.2000 ± 0.0433 and

treatment. The results of statistical analysis are shown in the Table 13.

4.3.2 Total volatile bases of headon prawns.

On the initial day of storage the TVB content of the control and purged samples were 28.0222 ± 1.9064 and 17.2360 ± 0.8165 mg N / 100 g of meat, On the third day it increased to 34.3569 ± 0.6867 and 21.77507 ± 2.6194 mg N / 100 g of meat and then gradually decreased by the seventh day to 22.5234 ± 1.5992 and 12.0982 ± 1.2600 mg N / 100 g of meat. This is shown in the Fig. 18.

The statistical analysis shows significant difference between the control and the purged sample. The statistical analysis is shown in the Table 14.

4.3.3 Non protein nitrogen of headon prawns.

The NPN content showed a change from 0.4738 ± 0.0125 and 0.4277 ± 0.0090 g N / 100 g. of meat to 0.5294 ± 0.0079 and 0.4697 ± 0.0090 g N / 100 g. of meat by the third day of storage and decreased to 0.3961 ± 0.0082 and 0.3785 ± 0.0096 g N / 100 g. of meat on the seventh day for the control and the purged sample respectively. This is shown in the Fig. 19.

The statistical analysis shows significant difference between the control and the treated sample. The results of statistical analysis is shown in the Table 15.

4.3.4 pH of headon prawns.

On the initial day of storage the pH of the samples were 7.2600 ± 0.0433 and

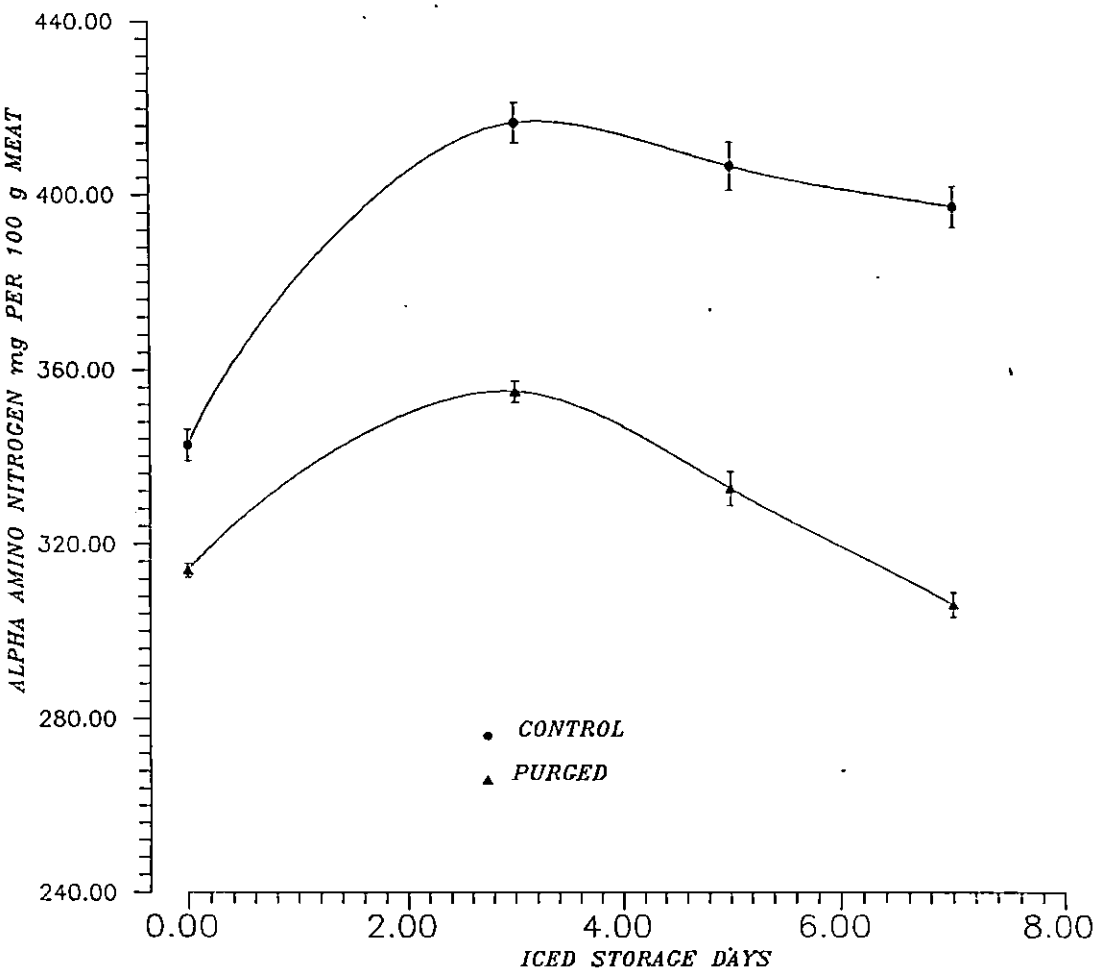

Fig. 17 Variation of alpha amino nitrogen *in headon prawns during iced storage*

Table 13. Analysis of variance for alpha amino nitrogen in headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	8203.833	8203.833	94.8992*
BETWEEN DAYS	3	22717.5	7572.5	87.5961
INTERACTION	3	1450.001	483.3336	5.5910
BETWEEN CELLS	7	32371.33	4624.476	53.4944
ERROR	16	1383.166	86.4479	
TOTAL	23	33754.5	t (5%) = 2.1200	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

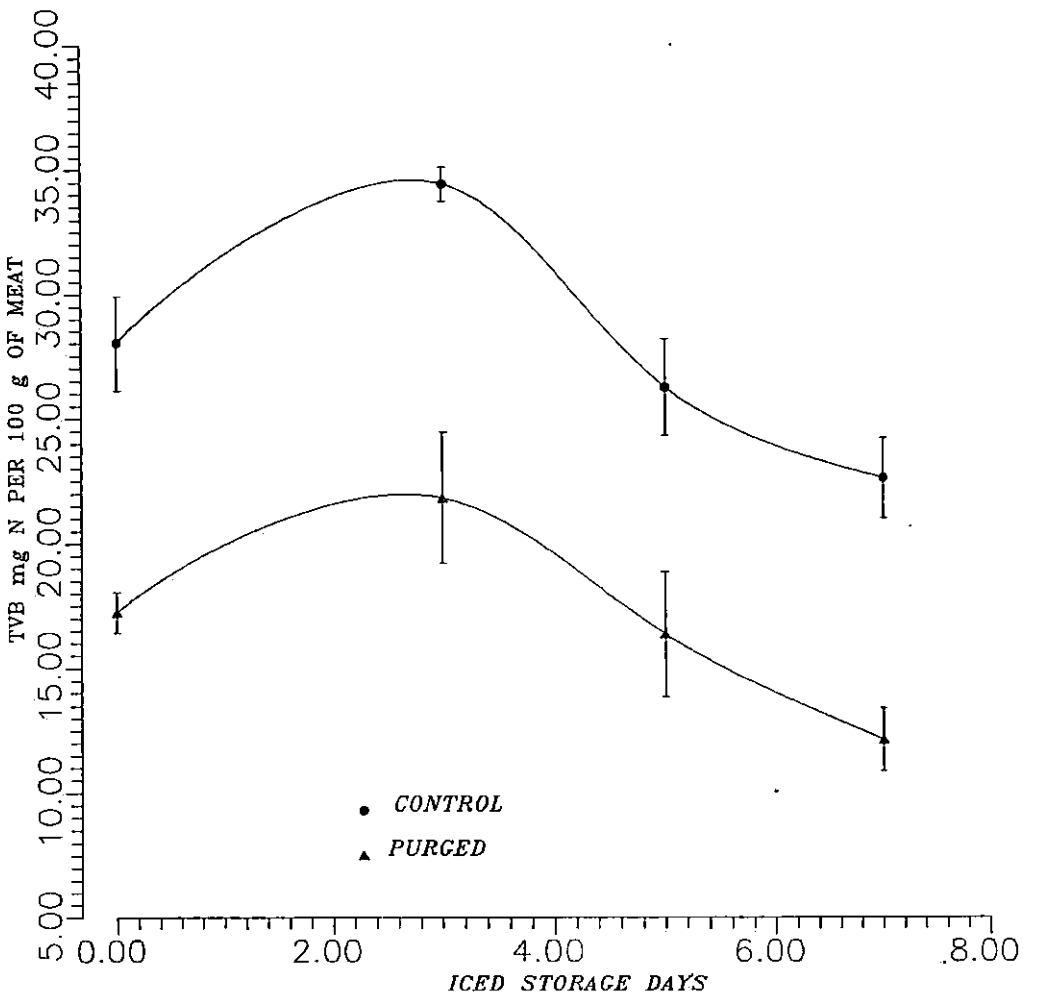

Fig. 18 Variation of total volatile bases in headon prawns during iced storage

Table 14. Analysis of variance for total votatile bases in headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	714.0355	714.0355	148.3642*
BETWEEN DAYS	3	356.2152	118.7384	24.6718
INTERACTION	3	6.3000	2.0933	0.43496
BETWEEN CELLS	7	.1076.5310	153.7901	31.9550
ERROR	16	77.0035	4.8127	
TOTAL	23	1153.5340	t (5%)= 2.1200	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

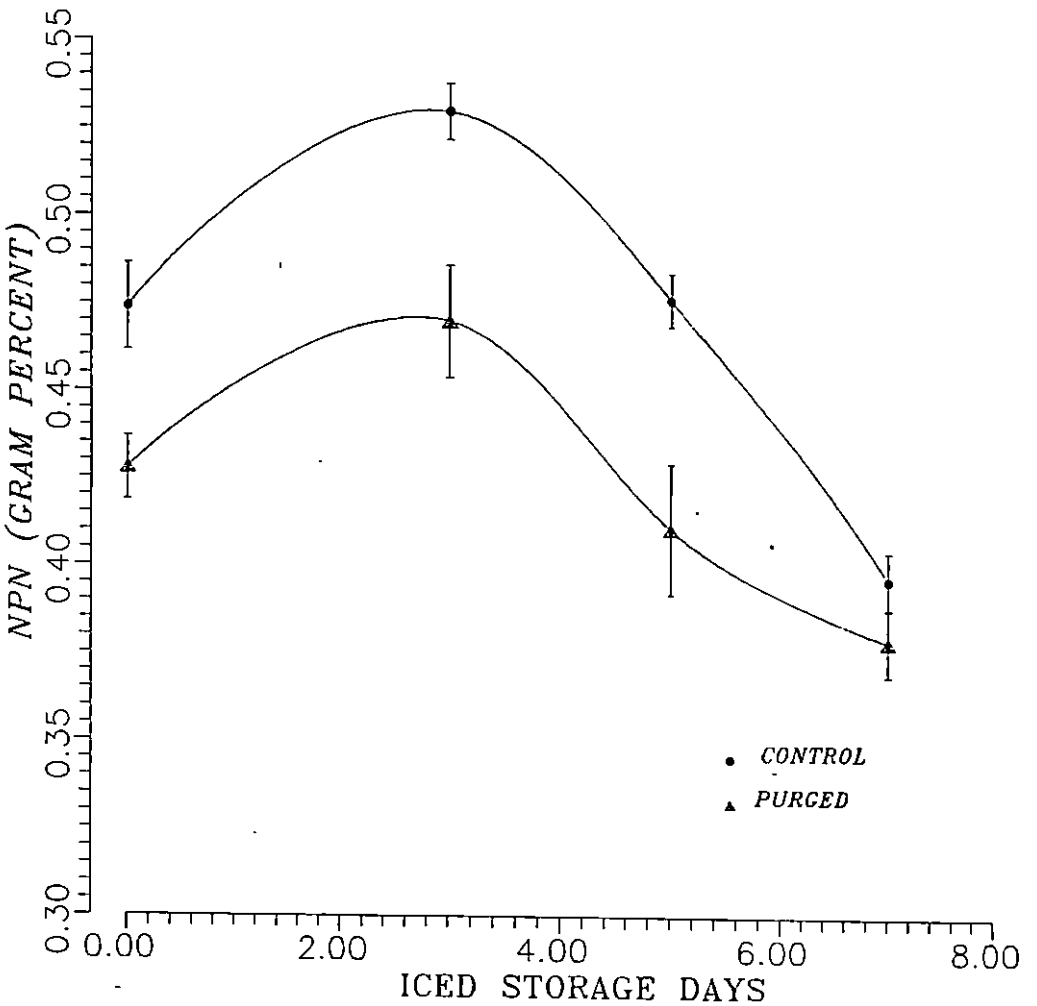

Fig. 19 Variation of non protein nitrogen in headon prawns during iced storage

Table 15. Analysis of variance for non protein nitrogen in headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	0.0134	0.0134	63.7902*
BETWEEN DAYS	3	0.0380	0.0127	60.4075
INTERACTION	3	0.0020	0.0005	2.4357
BETWEEN CELLS	7	0.0535	0.0076	36.3937
ERROR	16	0.0034	0.0002	
TOTAL	23	0.0568	t (5%) = 2.1200	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

7.2267 ± 0.0205. By the 7th day of storage the pH was 7.9600 ± 0.0217, 7.9300 ± 0.0077 for the control and the purged sample. This is shown in the Fig. 20

The statistical analysis shows significant variation between the control and the purged prawn (Table 16).

4.3.5 Acid insoluble ash of headon prawns.

The acid insoluble ash shows significant difference between treatments and not between days. Mean value for all the days for control is 0.01552% and for the purged sample is 0.00117 % (Fig. 21 & Table 17.).

4.4 Sensory evaluation of the headon prawn

The sensory evaluation was done for both the raw and cooked sample. A sensory panel of nine members were made for the sensory evaluation.

4.4.1 Sensory evaluation of raw headon prawn.

The sensory attributes that were used in this test were Appearance, Odour and Texture.

4.4.1.1 Appearance of raw headon prawn.

The Appearance score showed a decrease from 7.8000 ± 1.0770 and 9.2000 ± 0.9798 during the first day of storage to 5.2000 ± 2.0396 and 5.8000 ± 1.4000 by the seventh day of storage for the control and purged prawn. This is shown in the Fig. 22.

The statistical analysis shown in the Table 18 shows significant difference

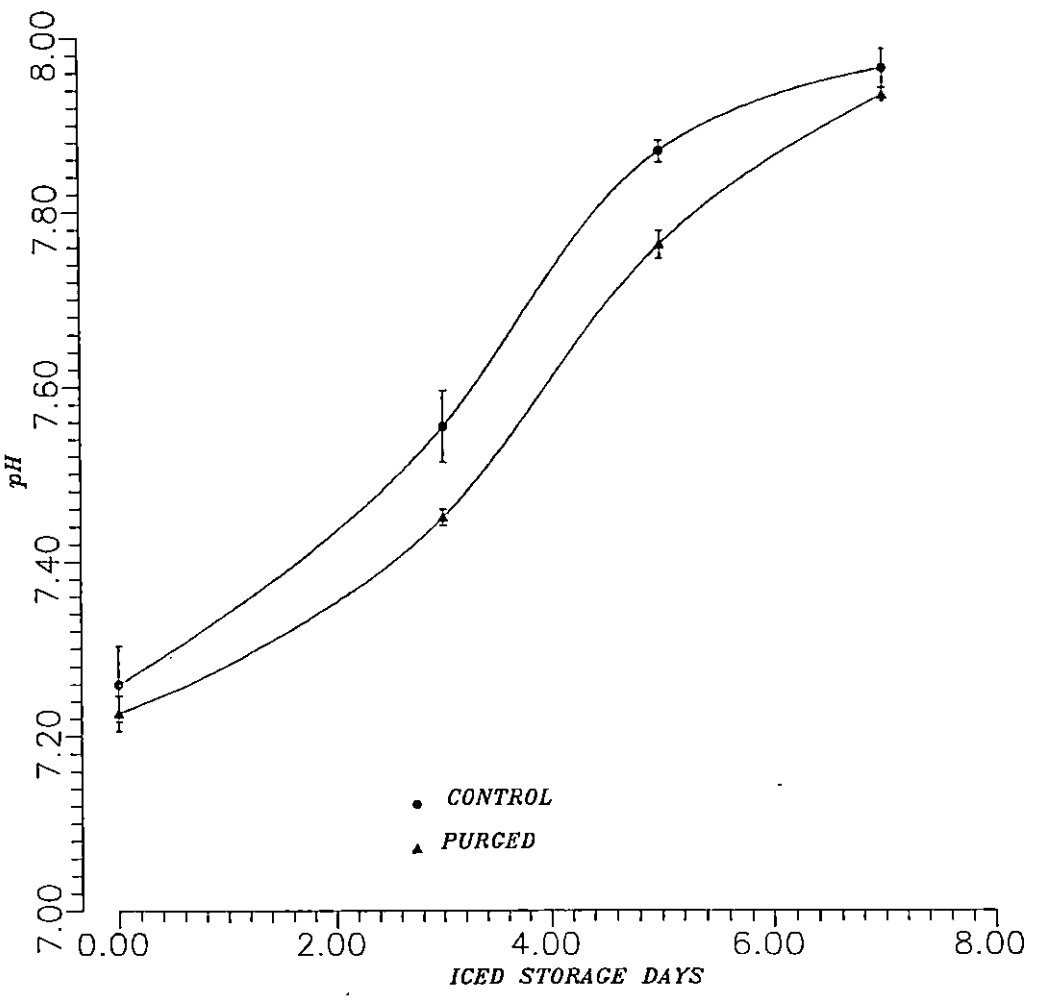

Fig. 20 Variation of pH in headon prawns during iced storage

Table 16. Analysis of variance for pH in headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	0.0278	0.0278	29.6152*
BETWEEN DAYS	3	1.7924	0.5975	636.6902
INTERACTION	3	0.0083	0.0028	2.9340
BETWEEN CELLS	7	1.8285	0.2612	278.3554
ERROR	16	0.0150	0.0009	
TOTAL	23	1.8435	t (5%) = 2.1200	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

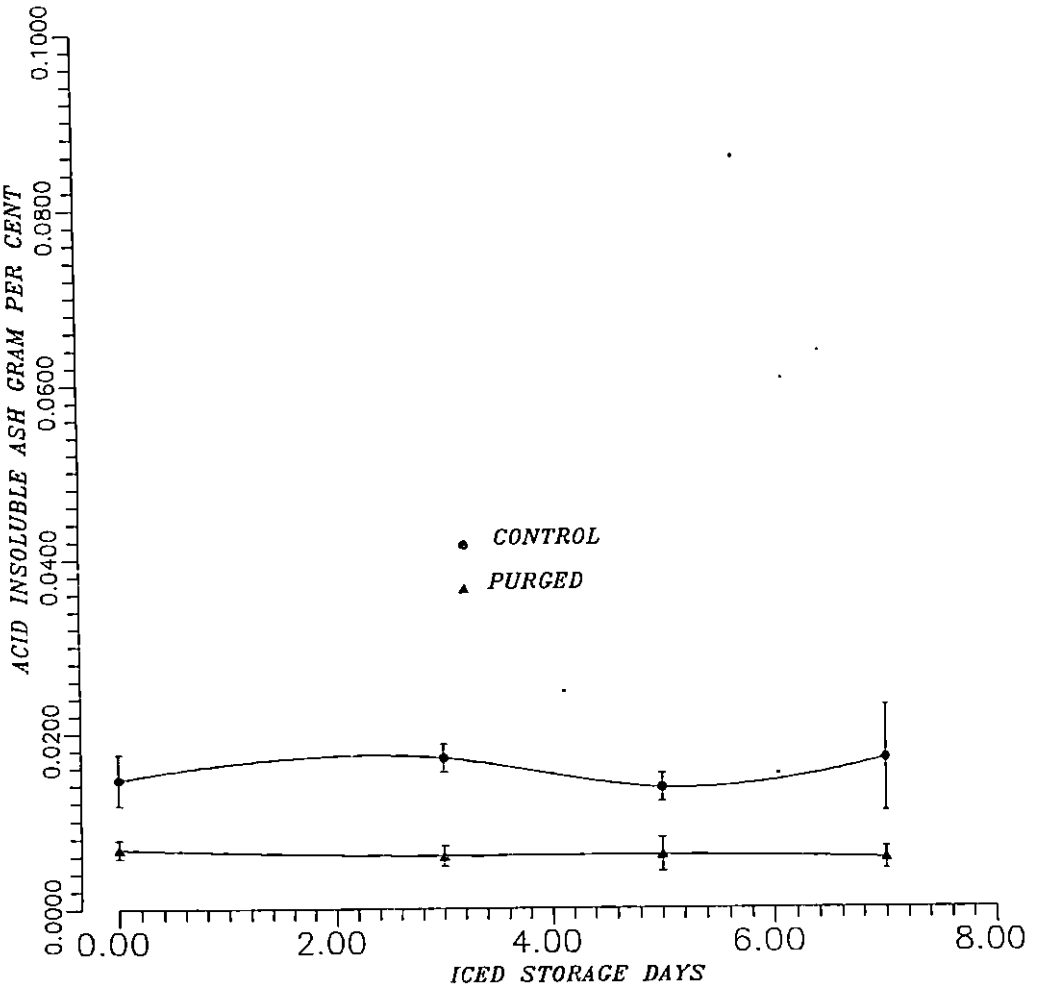

Fig. 21 Variation of acid insoluble ash in headon prawns during iced storage

Table 17. Analysis of variance for acid insoluble ash in headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	0.00053	0.00053	48.4045*
BETWEEN DAYS	3	0.00001	0.000003	0.3126
INTERACTION	3	0.000018	0.000006	0.5576
BETWEEN CELLS	7	0.000559	0.00008	7.2879
ERROR	16	0.000175	0.000011	
TOTAL	23	0.000734	t (5%) = 2.1200	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

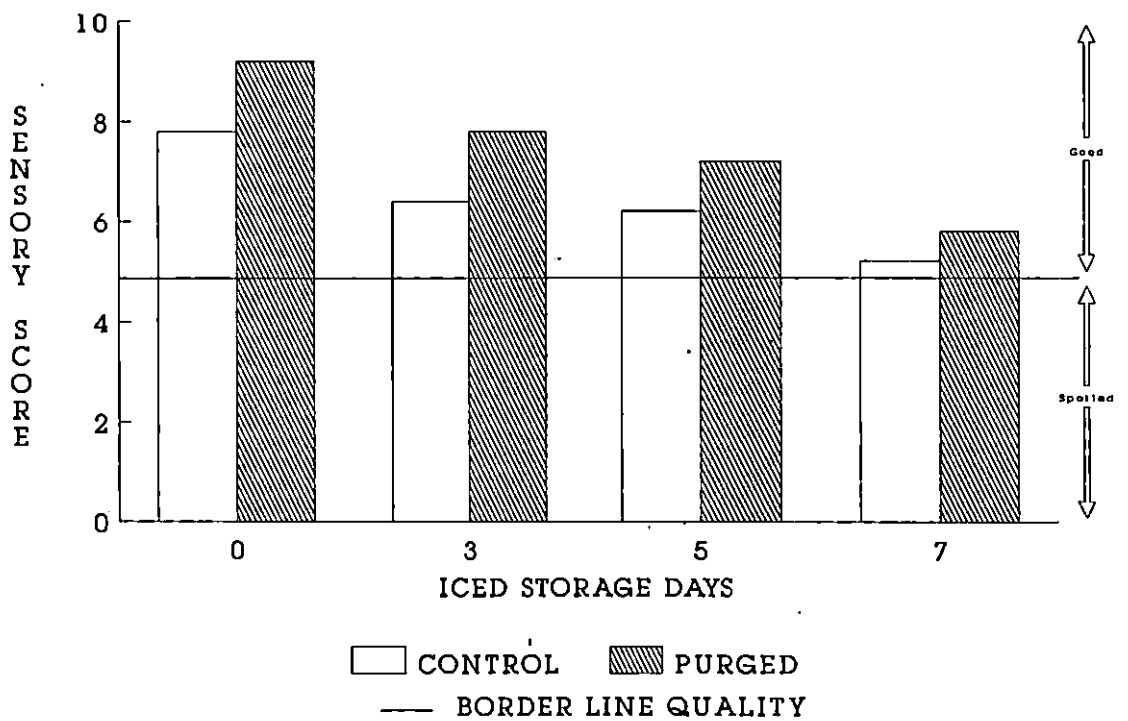

Fig.22 Variation of appearance score in raw headon prawns during iced storage

Table 18. Analysis of variance for appearance score of raw headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	24.2001	24.2001	9.3880*
BETWEEN DAYS	3	91.8001	30.6000	11.8707
INTERACTION	3	2.2000	0.7333	0.2845
BETWEEN CELLS	7	118.2001	16.8857	6.5505
ERROR	72	185.6000	2.5778	
TOTAL	79	303.8000	t (5%) = 1.9930	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

between the control and the treated sample .

4.4.1.2 Odour of raw headon prawn.

On the initial day the Odour scores were 8.8000 ± 1.3266 and 9.2000 ± 0.9798 and after 7 days of storage it decreased to 4.6000 ± 0.8000 and 5.5000 ± 1.024 for the control and the purged sample respectively. This is shown in the Fig. 23.

The statistical analysis shows significant difference between the control and the purged sample (Table 19).

4.4.1.3 Texture of raw headon prawn.

On the initial day of storage the texture scores were 8.8000 ± 1.6000 and 9.6000 ± 0.8000 and on the seventh day of storage it decreased to 6.0000 ± 1.5492 and 6.6000 ± 1.2806 for the control and the purged prawns respectively. This is shown in the Fig. 24.

The statistical analysis shows significant variation between the control and the purged sample. The statistical analysis is shown in the Table 20.

4.4.2 Sensory evaluation of cooked headon prawn.

The samples were cooked in boiling water for 15 minutes and were presented before the taste panel. The sensory attributes tested were Colour, Odour and Flavour.

4.4.2.1 Colour of cooked headon prawn.

The Colour scores were 8.2000 ± 1.0770 and 9.6000 ± 0.8000 on the 0 day of

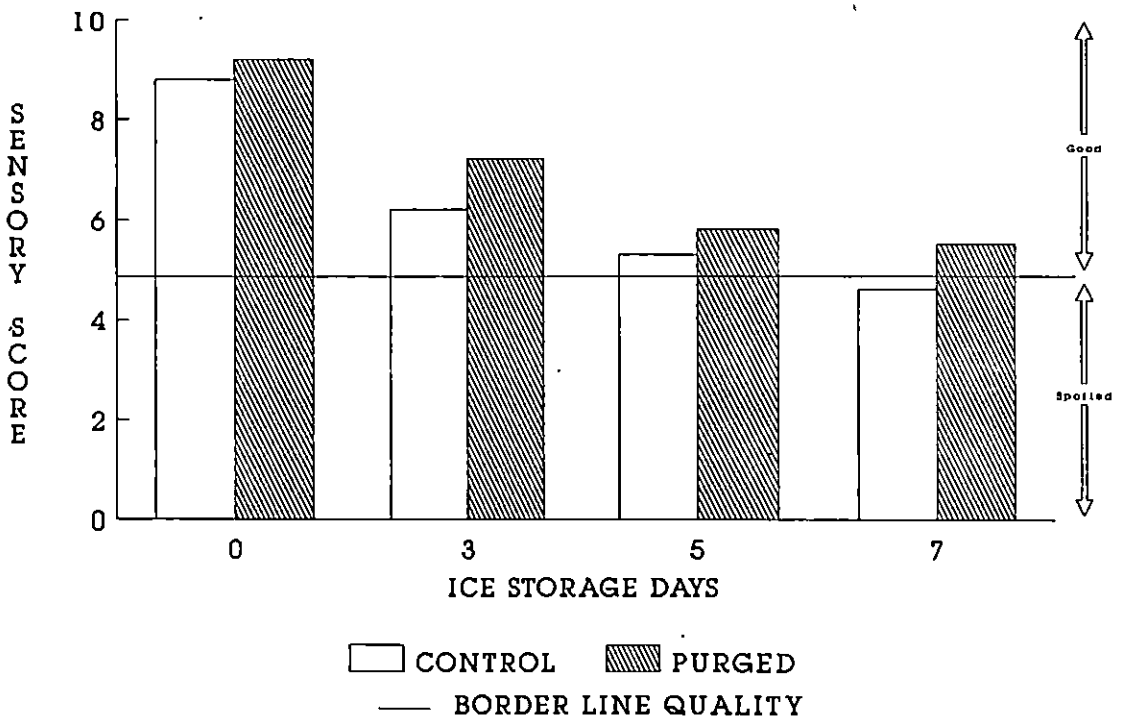

Fig.23 Variation of odour score in raw headon prawns during iced storage

Table 19. Analysis of variance for Odour score of raw headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	9.8000	9.8000	9.6658*
BETWEEN DAYS	3	185.4500	61.8167	60.9699
INTERACTION	3	1.3000	0.4333	0.4274
BETWEEN CELLS	7	196.5500	28.0786	27.6939
ERROR	72	73.0000	1.0139	
TOTAL	79	269.5500	t (5%) = 1.9930	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

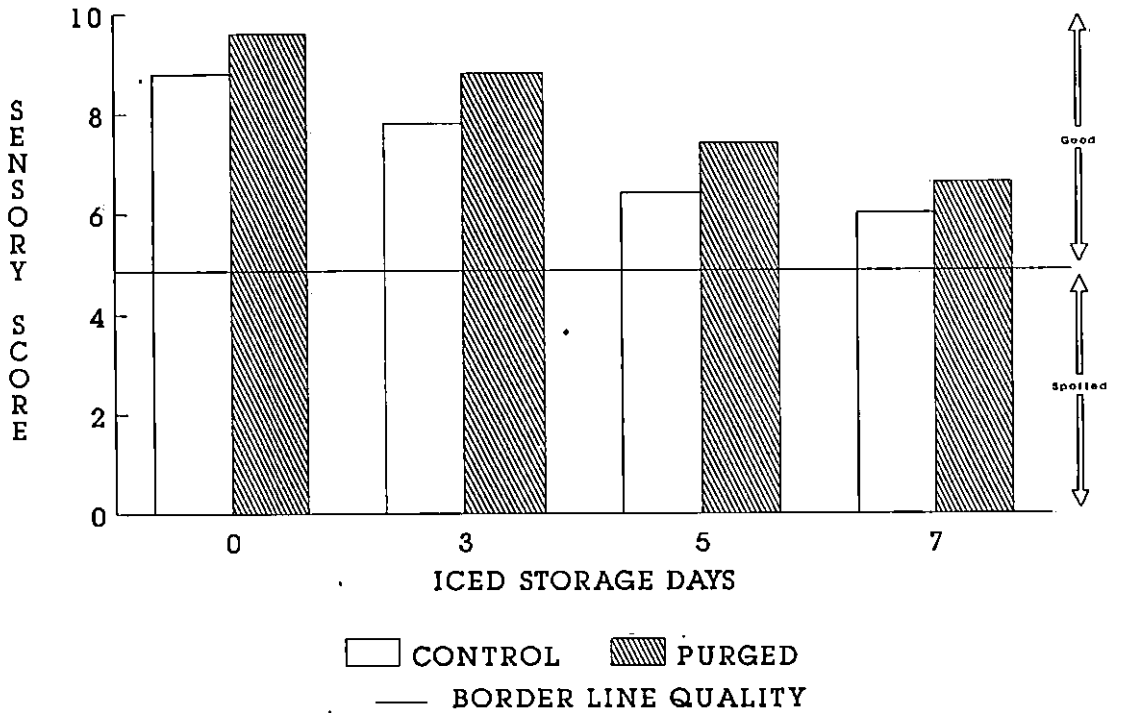

Fig.24 Variation of texture score in raw headon prawns during iced storage

Table 20. Analysis of variance for texture score of raw headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	14.4498	14.4498	6.6521*
BETWEEN DAYS	3	104.1498	34.7166	15.9821
INTERACTION	3	0.5502	0.1834	0.0844
BETWEEN CELLS	7	119.1498	17.0214	7.8359
ERROR	72	156.4000	2.1722	
TOTAL	79	275.5498	t (5%) = 1.9930	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

storage and the values decreased to 5.6000 ± 1.6248 and 6.0000 ± 1.7321 towards the seventh day of storage, for the control and the purged sample, as shown in the Fig. 25.

The statistical analysis shows a significant variation for the Colour scores between the control and the purged prawn. The statistical analysis is shown in the Table 21.

4.4.2.2 Odour of cooked headon prawn.

The Odour scores declined from the initial scores of 8.6000 ± 1.2806 and 9.6000 ± 0.8000 to 5.1000 ± 2.1190 and 6.1000 ± 1.0440 by the seventh day of storage for the control and the purged sample. This is shown in the Fig. 26.

The statistical analysis shown in the Table 22 shows significant variation between the Odour scores of the control and the purged sample.

4.4.2.3 Flavour of cooked headon prawn.

On the 0 day of storage the Flavour scores (shown in the Fig. 27) were 8.2000 ± 1.0770,10.0000 and on the seventh day of storage the Flavour scores were 5.1000 ± 1.9209 and 5.7000 ± 2.1000 for the control and the purged sample.

The statistical analysis shows significant variation between the Flavour scores of the control and the purged prawn . The statistical analysis is shown in the Table 23.

4.4.2.4 Percentage of black vein of cooked headon prawn.

Percentage of black vein showed significant difference between treatments and no significant difference between storage days (Table 24). The presence of black vein was

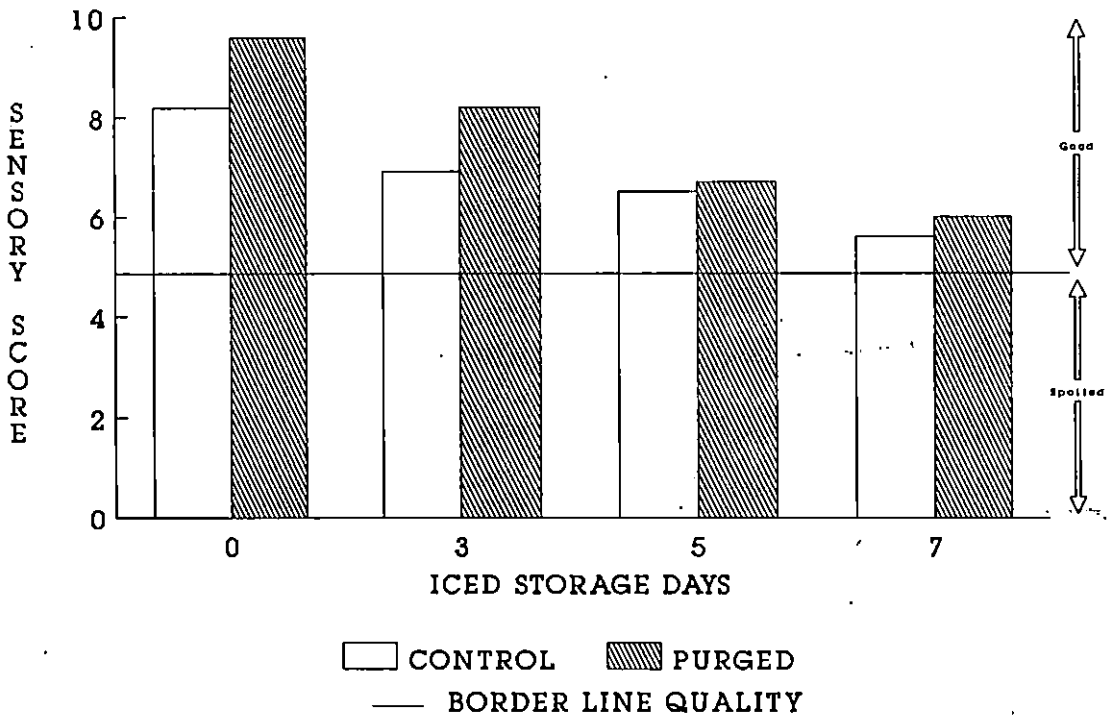

Fig.25 Variation of colour score in cooked headon prawns during iced storage

Table 21. Analysis of variance for colour score of cooked headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	13.6127	13.6127	7.6872*
BETWEEN DAYS	3	106.6377	35.5459	20.0730
INTERACTION	3	5.6373	1.8791	1.0611
BETWEEN CELLS	7	125.8877	17.9840	10.1557
ERROR	72	127.5000	1.7708	
TOTAL	79	253.3877	t (5%) = 1.9930	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

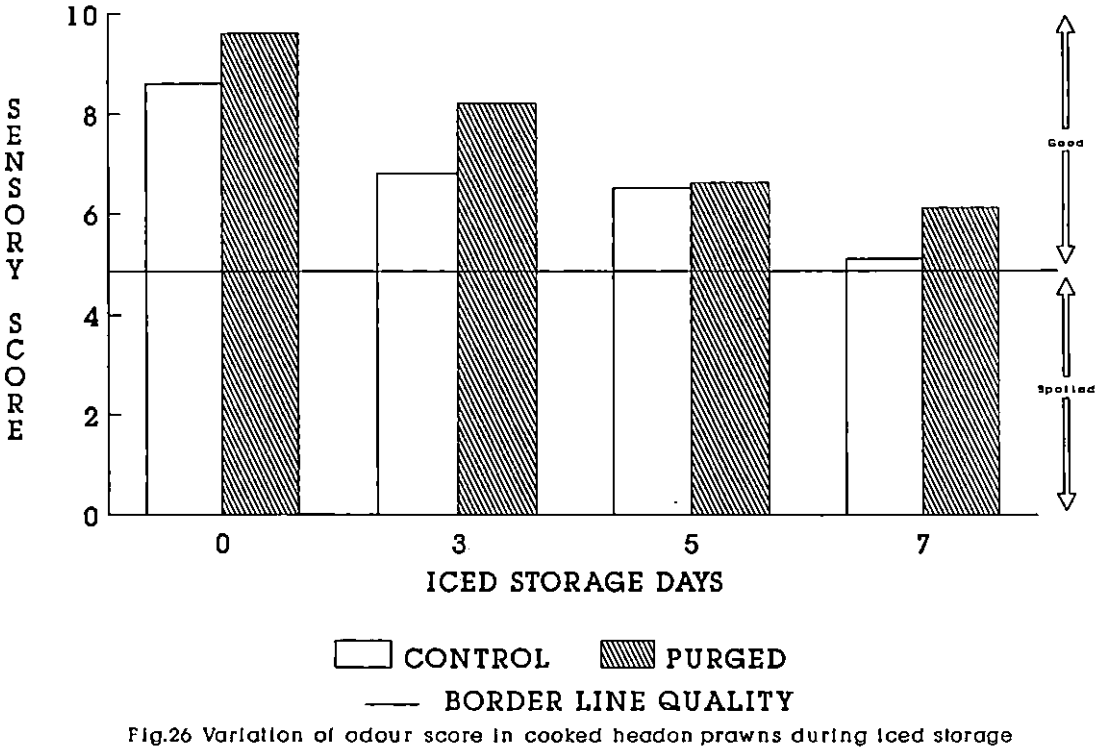

Fig.26 Variation of odour score in cooked headon prawns during iced storage

Table 22. Analysis of variance for odour score of headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	15.3125	15.3125	8.4353*
BETWEEN DAYS	3	133.6375	44.5458	24.5394
INTERACTION	3	4.5375	1.5125	0.8332
BETWEEN CELLS	7	153.4875	21.9268	12.0790
ERROR	72	130.7000	1.8153	
TOTAL	79	284.1875	t (5%) = 1.9930	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

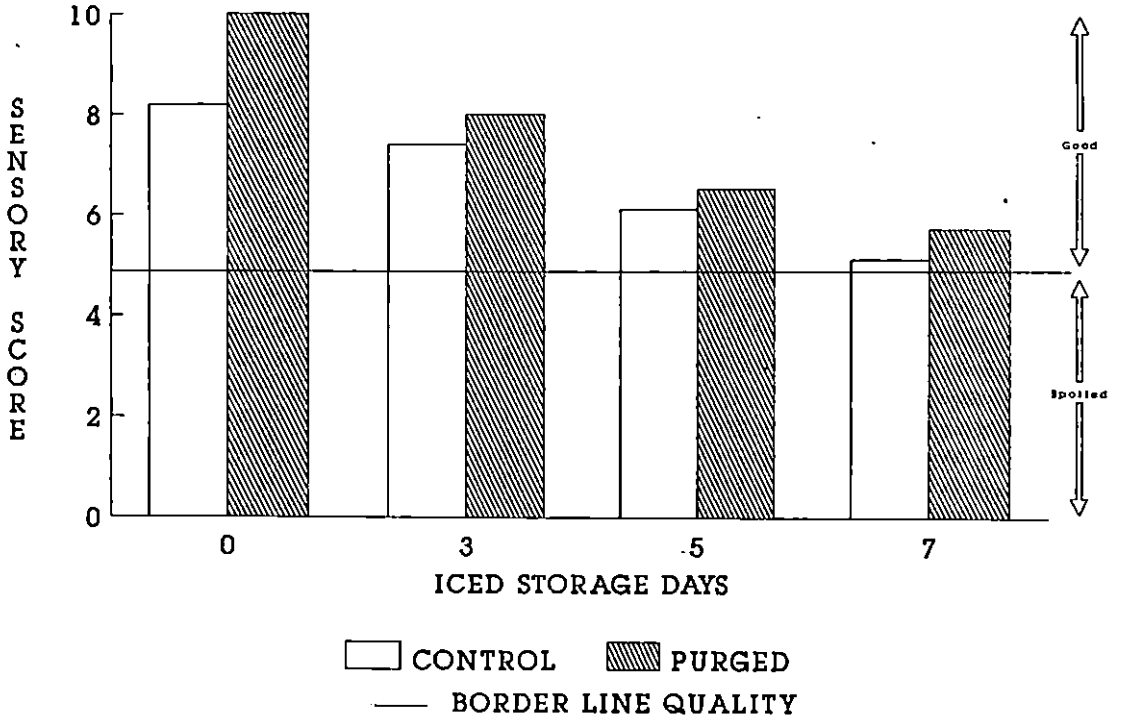

Fig.27 Variation of flavour score in cooked headon prawns during iced storage

Table 23. Analysis of variance for flavour score of headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	14.4500	14.4500	5.8980*
BETWEEN DAYS	3	157.7500	52.5833	21.4626
INTERACTION	3	6.1500	2.0500	0.8367
BETWEEN CELLS	7	178.3500	25.4786	10.3994
ERROR	72	176.4000	2.4500	
TOTAL	79	354.75	t (5%) = 1.993	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

79.25 per cent and 32.75 per cent for the control and the purged sample respectively (Fig. 28).

4.4.2.5 Mushiness of cooked headon prawn.

Mushiness was observed only from the third day onwards, for the control it was 57 % and for the purged sample it ws 18% by the 7^{th} day mushiness was 100 % in both samples (Fig.29). The analysis of variance show significant difference between the treatments (Table 25).

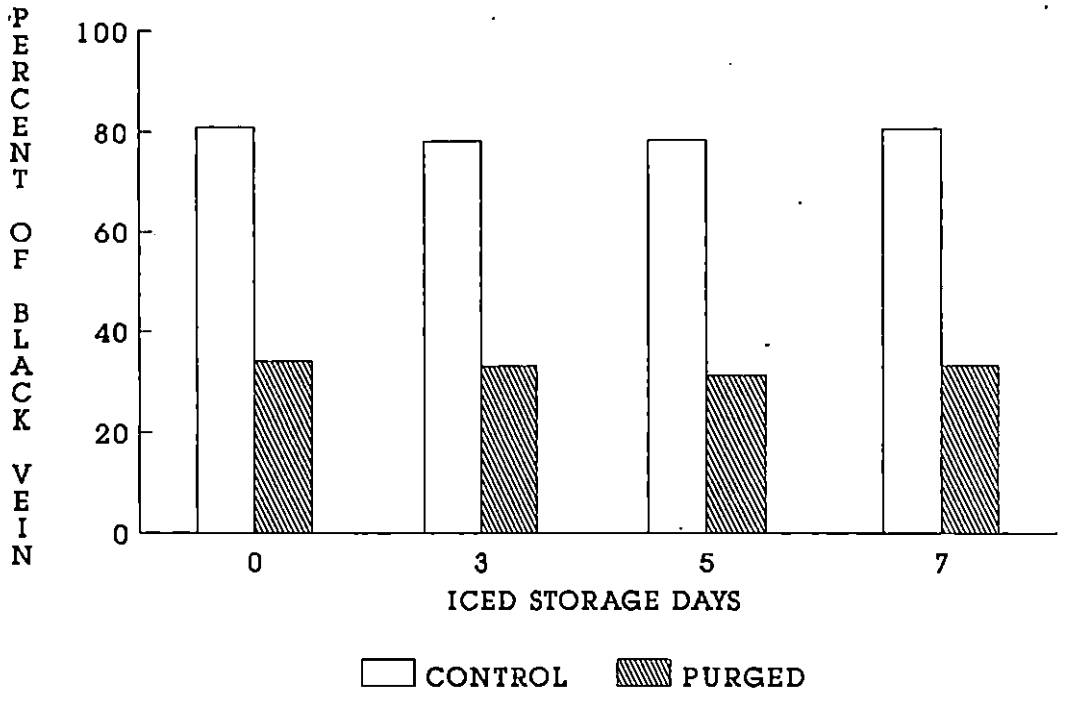

Fig.28 Variation of percentage of black vein in cooked headon prawns during iced storage

Table 24. Analysis of variance for percentage of black vein in cooked headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	43245	43245	474.6402*
BETWEEN DAYS	3	100.0000	33.3333	0.3659
INTERACTION	3	15.0000	5.0000	0.0549
BETWEEN CELLS	7	43360	6194.286	67.9861
ERROR	72	6560	91.1111	
TOTAL	79	49920	t (5%) = 1.9930	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

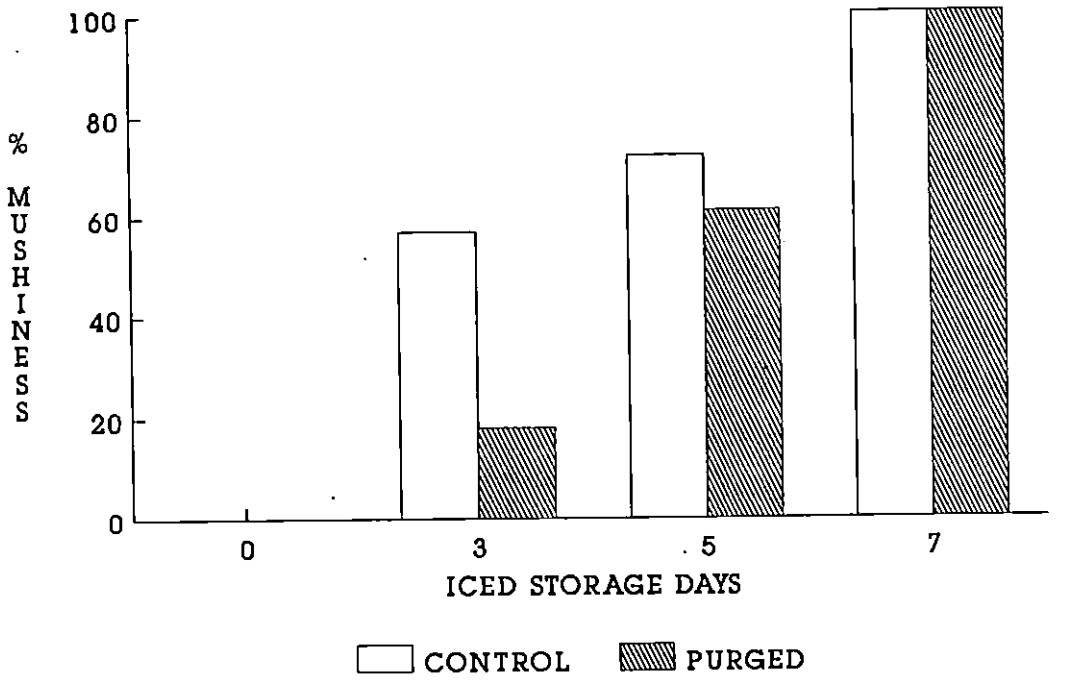

Fig. 29 Variation of mushiness in cooked headon prawns during iced storage

Table 25. Analysis of variance of mushiness in cooked headon prawns during iced storage

SOURCE OF VARIATION	DF	SS	MSS	F RATIO
BETWEEN TREATMENTS	1	3125	3125	101.3513*
BETWEEN DAYS	3	108490	36163.33	1172.865
INTERACTION	3	5085	1695	54.97297
BETWEEN CELLS	7	116700	16671.43	540.6949
ERROR	72	2220	30.83333	
TOTAL	79	118920	t (5%) = 1.993	

* significant difference between the treatments

Pair wise comparison

Control[a]

Purged[b]

Treatment with different superscripts show significant variation.

DISCUSSION

V DISCUSSION

5.1 Alpha amino nitrogen

The alpha amino nitrogen content of fresh prawns are usually in the range of 117 to 227 mg per 100 g of muscle (Pillai *et al.*, 1961). In this study the alpha amino nitrogen was above this value and showed a fluctuation in quantity in the headless prawns during storage. However, in the case of headon prawns, there was a gradual increase in alpha amino nitrogen during the storage in ice. Clark and Almy (1917a) found an increase in amino nitrogen with increase in spoilage. Alpha amino nitrogen was found to increase during storage in ice by Campell and Williams (1952), Pillai *et al.*(1961), Uchiyama *et al.*(1966), Cobb *et al.*(1974), Shaban *et al.*(1987), Chen *et al.*(1990) and Matsumoto and Yamanaka(1991). According to Pedraja (1970) free amino acids in prawns increase during storage in ice and after reaching a peak they begin to decrease.

In the headless prawns the content of alpha amino nitrogen was 348.0982 $\pm$ 1.9729 mg / 100 g on the initial day for the undepurated control. On the third day of iced storage it had increased to 349.0481 $\pm$ 3.8635 mg / 100 g and then it decreased to 314.6971 $\pm$ 2.8641 mg / 100 g during the fifth day of storage. This decrease may be due to the consumption of the free alpha amino nitrogen by bacteria or enzymes or by osmosis (Pedraja, 1970). Again the alpha amino nitrogen content decreased to 313.2065 $\pm$ 3.801 mg N / 100 g of meat on the eighth day of storage and showed a decrease to 301.5492 $\pm$ 0.8972 mg /100 g by the tenth day. Decrease in alpha amino nitrogen in prawns during iced storage was detected by Fieger and Firloux (1954); Velankar *et al.*(1961); Jacob *et al.*(1962); Lakshmi *et al.*(1962 a); Govindan (1972); Iyer *et al.*(1969); Velankar and

Govindan (1959); Sastry and Srikar (1986) and Perigreen *et al.*(1987). Leaching of free amino acids during iced storage of shrimp has been observed by Velankar and Govindan (1959); Iyengar *et al.* (1960); Waterman (1966); Pedraja(1970); Cobb *et al.* (1973, 1974) and Afser (1980).

The purged prawn showed an initial concentration of alpha amino nitrogen as 351.0235 $\pm$ 6.0865 mg/100 g This is more than the control, perhaps owing to greater stress to the animal while purging in a small container. Chen *et al.*(1990) found an increase in alpha amino nitrogen during live transportation of prawn. According to Pedraja (1970) increased stress can vary the amino acid pool of shrimp. For the present study, on the third day of storage the alpha amino nitrogen content was 355.8255 $\pm$ 2.9920 mg / 100 g, this value is also more than that in the control. The increase in alpha amino nitrogen is due to the action of psychrophilic bacteria in combination with the enzymes (Pedraja 1970). Then the alpha amino nitrogen showed a decreasing trend and on the 10^{th} day of storage it was 300.9142 $\pm$ 3.6990 mg / 100 g showing consumption by bacterial, enzymic or leaching action. This view is supported by Fieger and Firloux (1954); Velankar *et al.*(1961); Jacob *et al.*(1962); Lakshmi *et al.*(1962); Govindan (1972); Iyer *et al.*(1969); Velankar and Govindan (1959); Sastry and Srikar (1986) and Perigreen *et al.*(1987).

The prawn that was dipped in chlorine water after purging showed the highest initial content of the alpha amino nitrogen of 440.8091 $\pm$ 13.4812 mg /100 g. This may be due to stress that could have occurred by the chlorine dip. Chen *et al.*(1990) found an increase in alpha amino nitrogen during live transportation of prawn. According to

Pedraja (1970) increased stress can vary the amino acid pool of shrimp. On the subsequent days of storage the variation in alpha amino nitrogen showed a similar variation as in the above two cases.

The alpha amino nitrogen content of the headon samples showed a different pattern of variation when compared to the headless prawns during iced storage. The alpha amino nitrogen contents were 342.6568 $\pm$ 3.6863 mg N / 100 g of meat for the control and 314.0774 $\pm$ 1.563 mg N / 100 g of meat for the purged sample on the initial day. The values increased on the 3rd day to 433.0729 $\pm$ 1.0913 and 354.88 $\pm$ 2.44, then gradually decreased and on the 7th day they were 396.5681 $\pm$ 4.6748 and 305.8424 $\pm$ 2.8663 mg N / 100 g of meat for the control and the purged sample. The higher amount of alpha amino nitrogen in the control may be from the intestinal contents which contains the digested feed matter and in the treated sample the quantity of the ingested matter is reduced by purging so as to reduce the free alpha amino nitrogen. This shows the efficiency of purging. The statistical analysis backs this. The analysis of variance shows a significant variation between the control and the purged sample and the latter is found to be of better quality than the control.

5.2 Total volatile bases

The total volatile bases for the headless and headon samples on the initial day ranged from 17 to 23 mg N / 100 g of meat. Angel *et al.*(1981) reported that the TVN content of *M. rosenbergii* is 22 mg N / 100 g of meat. Prawns in fresh condition showed TVN values of 8.4 to 21.5 mg% (Pillai *et al.*,1961). Cann (1971) reported 27 mg N / 100 g of meat for shrimps.

For the headless prawns the TVB at first showed an increase upto the third day of storage in both the control and the purged chlorine treated prawns. In the case of the purged prawns the peak was shown on the 5th day of storage. According to Cobb *et al.* (1974) the post mortem production of basic volatile nitrogen is by both bacteria and enzymes, and it can get reduced by the loss of volatile and amino acid nitrogen following the loss of liquid from muscular tissue after death. The reduction in TVB is evident from the result that the TVB content after the fifth day of storage showed a decrease until the final day of iced storage for the control, purged sample and the chlorine treated purged sample.

On the initial day the TVB content of the treated samples were higher than the control which may be due to the stress on the animal since these animals were purged in a small tank and the purging time was 5 hours. Chen *et al.*(1990) reported that volatile base nitrogen accumulated in both iced and oxygenated grass prawns (*P. monodon*) during 26 hrs of storage and transportation period.

For the headon prawn on the initial day of storage the TVB content of the control was 28 mg N / 100 g of meat. It increased till the third day and gradually decreased till the seventh day. For the purged sample the initial TVB content was 17.2360 mg N / 100 g of meat and similar to the control showing an increase till the third day and then gradually decreasing by the 7th day of storage.

The high content of TVB in the control may be due to the gut contents and the low TVB of the purged sample is due to the flushing of the gut contents which contain bacteria and enzymes. According to Almanoos *et al.* (1984) who believed TVB in fresh

fish muscle is due to the formation of TMA from TMAO by bacterial activity; small amounts of DMA are also produced by enzymatic activity.

Here the purged sample is found to be less spoiled than the control during the iced storage since the content of TVB was less for the purged sample. This observation is supported by the statistical analysis.

5.3 Non protein nitrogen

The NPN content ranged from 0.5215 to 0.4277 g% in this experiment on the initial day. According to Joseph *et al.*(1992) the NPN content of *M. rosenbergii* was 0.490g%, and Sherief *et al.*(1992) reported that the NPN ranged from 320 to 440 mg N / 100 g of meat.

In the current study for the headless prawns the NPN content of the control, purged and purged chlorine dipped prawns were found to increase till the third day and from thereon, until the 10^{th} day of storage it showed a declining trend. According to Pillai *et al.*(1961); Jacob *et al.*(1962); Lakshmi *et al.*(1962) and Iyer *et al.*(1969) NPN is found to decrease during ice storage. The initial increase of NPN in this experiment may be due to the enzymatic action during ice storage. Between the treatment there is a slight difference in the quality and the chlorine dipped prawn is of poor quality than the control and the purged prawns. However, sensory analysis does not confirm this.

For the headon prawn the NPN content showed an increase on the third day of storage and decreased till the seventh day of storage for both the control and the purged sample. The NPN showed a very low value for the purged sample. This may be due to the flushing of the intestinal contents which may contain digested/undigested food,

enzymes etc which may contribute to the NPN. Here it is evident that purging has reduced the NPN content.

Since NPN includes free amino acids; volatile nitrogen bases, particularly ammonia (Asikari *et al.*, 1938; Minato, 1949; Jones, 1954), NPN also showed a similar variation as in the case of alpha amino nitrogen and TVB.

5.4 pH

All the treatments in the case of headless sample showed an acidic pH during the initial day of storage. Nip *et al.*(1985 a) reported a pH of 6.87 for *M. rosenbergii*.In the present study the pH increased for the control and the purged chlorine dipped sample by the 8th day of storage, and then decreased marginally by the 10th day of storage. For the purged in running water sample the peak pH was noticed on the 10th day of storage. The lower pH during the initial days may be due to the struggling of the animal before death which may have increased the lactic acid content. Increase in pH during iced storage was reported by Nip *et al.*(1985a); Chen *et al.*(1990); and Waters and Hale (1981). The increase in pH may be due to the increase in NPN and TVB. The chlorine dipped sample was having statistically significant difference as compared to the control and the purged prawns.

On the initial day of storage the pH of the headon samples were above 7 and increased till the 7th day of storage for the control and the purged sample. The statistical difference between the treatments was very high and the purged prawn is of better quality than the control. Nip *et al.*(1985 a) did not find any statistically significant difference in pH of the purged and the control *M.rosenbergii* at 5% level of significance. This suggests

that purging seems to be more effective in cases where the scampi is not beheaded during iced storage.

5.5 Acid insoluble ash

Acid insoluble ash did not show any statistically significant variation either between treatments or between days during the storage time for the headless prawns.

For the headon prawns the acid insoluble ash shows a significant difference between treatments and not between days. This is because of the flushing of sand and mud from the gut by purging. Mean value for all the days for the control is 0.01552% and for the purged sample is 0.00117%

For the purged headon prawn the spoilage indices were found to increase during storage. In these prawns during storage there was no loosening of the shell and no head drooping till the seventh day of storage. Presence of shell might have reduced the leaching of the minerals into melt water. Also, since the prawns were kept in a refrigerator near 1°C, such low temperature would have contributed to the low meltage of ice, thus leading to a reduction in the formation of melt water and the consequent reduced leaching.

5.6 Sensory evaluation

All the sensory parameters (Appearance, Odour and Texture of the raw prawn and Colour, Odour and Flavour of the cooked prawn) evaluated showed a similar declining trend during iced storage for both headless and headon prawn. Mushiness was not observed in the headless prawns. Mushiness started from the third day for the headon

control and the fifth day for the purged headon prawn. Nip *et al.*, (1985a) found that mushiness of the prawn was reduced by 20% as a result of purging. Beheading seems to further substantially influence reduction in mushiness as found in the current study. Further, the longer duration of purging in the case of headon prawns may have had its own influence on the lower development of mushiness.

The headless prawns showed a borderline quality on the 10th day of storage and headon prawns on the 7th day of storage. According to Cheuk *et al.*(1979) good quality was retained upto 10 days of ice storage. But Angel *et al.*(1981) detected spoilage after 14 days of iced storage of *Macrobrachium rosenbergii*. Alvarez and Koberger (1979) reported that objectionable odours are developed after 11 days of storage on ice and Vanderzant *et al.*(1974) found that half of the shrimp became unacceptable after 7-14 days on ice. Cobb *et al.*(1976) found that spoilage odours were evident after 11-15 days of ice storage. Iyer *et al.*(1969) found out from the flavour score that peeled and deveined prawns can be preserved for a maximum period of 5-6 days irrespective of species, while whole and headless for 4-5 days and 6-7 days respectively.

In the present study for the headless prawns, purging seemed to have no effect on quality. However, in the case of the headon prawn purging seems to have improved the quality of the prawn significantly. Nip *et al.*(1985a) working on scampi, observed an improvement in appearance due to purging.

For the headless prawns the treatments had no effect on the percentage of black vein content due to 5 hr purging. However for the headon prawns, percentage of black vein showed significant difference between treatments during the present study. The

percent of black vein was 79.25% and 32.75% for the control and the purged samples respectively. Nip *et al.*(1985a) observed a noticeable reduction in percentage of black vein from 82% to 47% by purging the scampi.

Since purging was done for 5 hours in the case of the headless prawns and 18 hours in the case of headon prawn a noticeable difference is observed in the percent of black vein. This reflects the effectiveness of purging for 18 hours.

The analyses of variance for the content of various quality indices like alpha amino nitrogen, TVB, NPN, pH and sensory evaluation show a significant variation between the control and treated prawn in the case of head on product style. For the headless prawn,purging did not show any marked difference with the control whereas for the headon prawns, the purged sample was of better quality than the control. Thus the advantage of purging may be evident only if the duration of purging is sufficiently long. Purging for a period of 5 hours is found to be inadequate and longer periods of purging viz. 15-18 hours under running water, without creating any conditions that would result in stress to the animals is recommended. Quality of scampi can be improved if the animal is purged overnight in running water tanks in live condition.

SUMMARY

VI SUMMARY

1 In this study the effect of purging the prawn *Macrobrachium rosenbergii* to improve its quality during iced storage was studied. Various physical and biochemical changes during iced storage was observed.

2 Alpha amino nitrogen showed a fluctuation in quantity in the headless prawns during storage. Chlorine dipped specimen showed more alpha amino nitrogen than the control and purged prawn. However, in the case of headon prawns, there was a gradual increase in alpha amino nitrogen during the storage in ice and the alpha amino nitrogen content was more for the control during storage.

3 The total volatile bases for the headless and headon samples on the initial day ranged from 17 to 23 mg N / 100 g of meat. For the purged-chlorine treated and beheaded prawns the TVB at first showed a higher value than the control and purged prawns showing increased spoilage of the treated sample than the control. For the headon prawns during iced storage the TVB content was higher for the control than the purged sample showing reduced spoilage of the treated sample.

4 The NPN content ranged from 0.5215 to 0.4277 mg% in this experiment on the initial day. For the headless prawns the NPN content was higher in the purged - chlorine dipped prawn than the control and purged prawn during the iced storage days. However for the headon prawns the NPN was higher for the control than the treated sample.

5 All samples showed an increasing trend of pH during iced storage. In the case of the purged - chlorine dipped -beheaded sample and the headon - control highest pH values were observed during storage.

6 Acid insoluble ash did not show any statistically significant variation either between treatments or between days during the storage time for the headless prawns. For the headon prawns the acid insoluble ash showed a significant difference between treatments and not between days because of the flushing of sand and mud from the gut by purging.

7 All the sensory parameters like Appearance, Odour and Texture of the raw prawn, and Colour, Odour and Flavour of the cooked prawn showed a similar declining trend during iced storage for both headless and headon prawn.The headless prawns showed a borderline quality on the 10^{th} day of storage and headon prawns on the 7^{th} day of storage. The samples were still acceptable on the 10^{th} and 7^{th} days respectively. Purging for 18 hours improved the quality of scampi.

8 Mushiness was not observed in the headless prawns. Mushiness started from the third day for the headon control and the fifth day for the purged headon prawns. Beheading seems to further substantially influence reduction in mushiness as found in the current study. Further, the longer duration of purging in the case of headon prawns may have had its own influence on the lower development of mushiness.

9 Since purging was done for 5 hours in the case of the headless prawns and 18 hours in the case of headon prawns a noticeable difference was observed in the presence of black vein. This reflects the effectiveness of purging for 18 hours.

10 In general it was noticed that the headless prawns kept longer than the headon prawns during iced storage. Mushiness problem was also not noticed in headless prawns.This is mainly attributed to the longer storage life due to beheading. The analysis of variance for the content of various quality indices like alpha amino nitrogen, TVB, NPN, pH and sensory evaluation showed a significant variation between the control and treated prawns in the headon product style. For the headless prawns, no difference was evident between the control and treatments wheras, for the headon prawns the purged sample was of better quality than the control. Thus the advantage of purging for a sufficient period of time is evident here.

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APPENDIX I

SENSORY EVALUATION OF ICE STORED PRAWN

The scampi samples provided to you for evaluation have been subjected to different treatments to eliminate their gut contents as a part of a study to assess the influence of gut contents on spoilage during iced storage. Your valuable opinion will be of immense relevance in this study. Thank you.

Time:

Date:

Name:

Kindly evaluate the raw scampi for three quality attributes. You may make a 'tick' mark in the appropriate column for all the three treatments a,b,c

ATTRIBUTES		TREATMENTS		
		a	b	c
1.Appearance	Score			
Excellent	10			
Good	8			
Fair	6			
Borderline	4			
Poor	2			
Very poor	0			
2.Odour	Score			
Extremely fresh	10			
Very fresh	8			
Moderately fresh	6			
Neutral	5			
Stale	4			
Very stale	2			
Putrid	0			
3.Texture	Score			
Firm & elastic	10			
Turning soft	8			
Soft, Elasticity lost	6			
Very soft	4			
Extremely soft	2			

Kindly evaluate the raw scampi for three quality attributes. You may make a 'tick' mark in the appropriate column or level for all the treatments a,b,c

Attributes		Excellent (10)	Good (8)	Fair (6)	Border line (5)	Poor (4)	Very Poor (2)	Bad (0)
Colour	a							
	b							
	c							
Aroma	a							
	b							
	c							
Flavour	a							
	b							
	c							
Percent Mushiness	a	0----------100						
	b	0----------100						
	c	0----------100						
Percent of Black vein	a	0----------100						
	b	0----------100						
	c	0----------100						

STUDIES ON THE EFFECT OF PURGING THE FRESHWATER PRAWN *MACROBRACHIUM ROSENBERGII* IN EXTENDING ITS ICED STORAGE LIFE

By

B.SUDHIR, B.F.Sc

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree

MASTER OF FISHERIES SCIENCE

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ABSTRACT

In this study the effect of purging the prawn *Macrobrachium rosenbergii* to improve its quality during iced storage was studied. Various biochemical and sensory changes that occurred during iced storage was observed. Experiments were done both for headless and headon prawns. For the headless prawns the treatments were (1) freshwater purged, and (2) purged and further chlorine dipped and the purging time was 5 hrs in a 500 litre tank. For the headon prawns purging in running water in a 5000 litre tank for 18 hrs was done. Both experiments were done with a control of unpurged prawns.

The headless prawns kept longer than the head on product style more so perhaps due to the effect of beheading. Analysis of variance for alpha amino nitrogen, TVB, NPN, pH and sensory evaluation showed significant difference between purged and unpurged samples in the headon product style, the purged sample being of better quality. Similar results were not evident in the case of headless scampi. Longer duration of purging for 18 hrs or longer seems to have an influence on quality. For the headon prawns the acid insoluble ash showed a significant difference between treatments indicating the success in flushing the gut contents by purging.

Sensory evaluation showed that headless and headon prawns were acceptable for more than 10 and 7 days respectively. Mushiness was not observed in the headless prawns but started from the third day for the headon control and the fifth day for the purged prawn. In headon prawn presence of black vein was reduced considerably by purging.

Thus it was seen that there was an improvement in the general quality of the prawn due to purging.