served, however, and we feel that the severed area contributes only a minor amount to the total volatiles. There seems no other practical way of obtaining the volatiles from the leaves without introducing other artifacts from the soil, environment, plastic containers, etc.

The volatile compounds in macerated wheat leaves reported by Hamilton-Kemp and Andersen (1984) are quite different from those found in the present work. As discussed in previous work [e.g., Buttery and Ling (1984)], damage to the plant material (maceration would cause extreme damage) gives rise to considerable oxidative enzyme activity that breaks down the plant lipid and carotenoid components to a relatively large amount of volatile aliphatic aldehyde and alcohol compounds that are not present in the intact plant [cf. Schwimmer (1981)]. Such enzyme-produced volatiles can completely obscure the original volatiles that may be 100 times less in concentration. The enzyme action might also destroy (e.g., oxidise) some of the volatiles present in the intact plant. To fully understand the attraction of insect pests to their specific host plants, it would seem of primary importance to identify the compounds emitted by the intact plant. Volatiles emitted by damaged plants may also be important in the attraction of certain insect pests.

Comparison with Oat and Barley Leaf Volatiles. The major volatiles found in the wheat leaves are qualitatively the same as those found by Buttery et al. (1982) in both oat and barley leaves (by Tenax trapping). The method using Tenax trapping is not well suited to good quantitative comparison but is satisfactory for semiquantitative information [cf. Dressler (1979)]. (*Z*)-3-Hexenyl acetate is the most predominant volatile in all three cereal leaves. It does appear to be, however, much more predominant in oat leaves than in either barley or wheat.

Registry No. 2-Pentanone, 107-87-9; (*Z*)-3-hexenal, 6789-80-6; 2-methyl-2-pentenal, 623-36-9; (*E*)-2-hexenal, 6728-26-3; nonanal, 124-19-6; 2-undecanone, 112-12-9; 1-penten-3-ol, 616-25-1; 2-methylbutanol, 137-32-6; 3-methylbutanol, 123-51-3; (*Z*)-3-hexenyl acetate, 3681-71-8; (*Z*)-3-hexenol, 928-96-1; octanol, 111-87-5; (*Z*)-B-ocimene, 3338-55-4; (*E*)-B-ocimene, 3779-61-1; linalool oxide A, 34995-77-2; linalool, 78-70-6; linalool oxide C, 39028-58-5; α-cubebene, 17699-14-8; α-copaene, 3856-25-5; caryophyllene, 87-44-5; (*E*)-β-farnesene, 18794-84-8; γ-muurolene, 30021-74-0; α-muurolene, 10208-80-7; α-farnesene, 502-61-4; δ-cadinene, 483-76-1.

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Quality Changes in Lobster (*Panulirus polyphagus*) Muscle during Storage in Ice

Riaz Fatima and R. B. Qadri*

Studies have been made on organoleptic, chemical, and microbiological changes in lobster (*Panulirus polyphagus*) tail muscle stored in ice up to 15 days simulating commercial practice. These changes were correlated with taste panel evaluations of the sensory quality. Significant correlation coefficients were obtained between the mean organoleptic response and the various objectively measured changes during the storage period. The merits of these changes as objective indices of quality, particularly in relation to taste panel assessment, are discussed.

The export of lobster is an important part of the seafood industry of Pakistan. In 1980, 16 tons of lobster valued at Rs. 1.93 millions in foreign exchange were exported in frozen, dried, and live forms ("Handbook of Fisheries Statistics of Pakistan", 1980). Great potential, however, exists for increasing its export in present forms as well as in canned and chilled forms.

For proper utilization attention must be given to the fact that lobster is highly perishable. This necessitates measures to be taken immediately after capture to prevent deterioration in quality. Quality problems are aggravated by the variability of raw material due to the influence of environment, food, season, etc., and by the biochemical reactions that take place after death and that are influenced by the physiological conditions at the time of catch.

Pakistan Council of Scientific and Industrial Research Laboratories, Karachi—39, Pakistan.

There are several reports of the general pattern of spoilage and storage stability of crustaceans. Loss of quality and subsequent spoilage of crustaceans and other seafoods are caused primarily by tissue enzymes and microbial activities. Various tests have been proposed to determine the quality and expected storage life of the raw product. Included are acid-soluble orthophosphate, trimethylamine nitrogen, amino nitrogen, extract release volume, pH, and bacterial count. At present, however, organoleptic measurements of quality are used for purchasing and grading seafoods at various stages during their storage life (Baily et al., 1956; Vanderzant and Nickelson, 1971; Cobb and Vanderzant, 1975; Farooqi et al., 1978). Different species of prawn and scampi (*Nephrops norvegicus*) showed that flesh from crustaceans spoiled at a faster rate than that from cod and other teleosts under similiar conditions (Fieger and Novak, 1961; Vyncke, 1968; Walker et al., 1970). Simidu (1961) reported that the higher rate of spoilage is due to a high proportion of amino

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acid nitrogen in the nonprotein nitrogen fraction of crustacean muscle. For example, lobster muscle contains 39% free amino acid nitrogen of the water-soluble NPN whereas fish muscle contains about 6% (Velankar and Govindan, 1957). Little information is available on the storage stability and keeping quality of lobster. Holland et al. (1972) evaluated several lobster handling methods to determine the best way of transporting lobster. It was concluded that the best method of maintaining the quality of lobster is to cook them as soon after harvest as possible and freeze them rapidly in individual containers (such as plastic bags). Sidhu et al. (1974a) studied the glycolysis of rock lobster (*Jasus novae hollandiae*) muscle under anaerobic conditions at 20, 15, and 0 °C. The role of amino acids in bacterial spoilage and production of volatile bases in the muscle of *J. novae hollandiae* has also been reported (Sidhu et al., 1974b). It was concluded that if rock lobsters are headed and gutted and the tails cooled immediately and kept out of contact of water, they could be kept in good condition up to a week. Thomas (1969) recommended the storage life of rock lobster to be 5 days.

The benefits to be derived from the use of ice and refrigeration for the preservation of fishery products has been studied extensively in fisheries of temperate zones. Relatively few studies have been reported on the value of this form of preservation in tropical countries.

Farooqi et al. (1978) studied the chemical and microbiological changes that occur during ice storage of shrimp (*Penaeus merguiensis*) under commercial conditions. These changes were compared as indices of quality in relation to organoleptic changes. The purpose of the present investigation was to extend the range of observations on tropical lobster and to study quality changes that occur during ice storage. Such study is important not only to introduce the distribution of lobster in ice but also to provide basis for the development of inspection and quality control systems. Although these are not operative at present, they will become necessary as the demand for good quality fresh lobster increases.

In the present paper, attention is confined to the changes that occur in lobster tail muscle as a result of autolytic and/or bacterial spoilage during storage in ice (0 °C) and to the examination of the merits of any such changes as objective indices of quality.

EXPERIMENTAL SECTION

Materials. Lobsters were obtained live from small fishing boats in Ibraheem Hydri. They were brought by fishermen who operate small boats and make short trips (less than 10 h). Lobsters were transported to the laboratory in clean cotton bags. In many studies on quality changes in shellfish muscle during storage, the animals were permitted to undergo severe exhaustion before death. This would result in marked antimortem degradation during animal stress. The lobster were killed immediately by removing their cephalothorax with a sharp knife. This method of slaughter was found to be quickest and minimized stress. The abdomen was not freed from the exoskeleton but the gut was removed. The tails that were to be analyzed for zero time were removed. Those for storage (shell on tails simulating commercial practice) were packed in perforated polythene bags and stored in ice in the ratio 1:1 (w/w). The lobster tails were kept in ice in plastic containers with holes in the bottom for draining, and these were put into another plastic container and kept in a refrigerator maintained at 4 °C. The lobster tails were constantly kept covered with ice during the storage period, reiced as required, and removed at 2, 4, 8, 11, and 15 days of storage for subjective and objective assessment of quality. A total of six experiments were conducted between March and Oct 1983. Results are presented as mean of six determinations at each evaluation date.

Physical Examination. At intervals during the storage period, lobster tails (raw and cooked) were examined for signs of quality deterioration. Particular attention was paid to the color, odor, flavor, and firmness of the flesh. Physical examination was based on olfactory evaluation of raw meat and both gastatory and olfactory evaluation of cooked meat.

Sensory Evaluation. The sensory evaluation was carried out by a panel of eight judges (employees of the division). All prospective panelists were trained in sensory evaluation of lobster tail. Panelists were screened, and those who did not like lobsters or had any food allergies were excluded. All panelists knew what constituted quality in lobster tail and were trained in differentiating appearance, flavor, and texture of ice-stored lobster tails. Tails after removing the exoskeletion were placed in boiling water for 5–7 min and tasted for flavor and texture and judged for appearance. A scale was worked out between 9 (extremely good) and 1 (very poor) for flavor texture and appearance. The score of each parameter was calculated in terms of score points awarded by a panel of judges to each sample.

Analytical Procedure. *Analysis of Gross Composition.* To assess the gross composition of raw lobster tails, representative samples were analyzed from composites (three tails in each composite) for moisture, ash, protein, lipid, amino acid nitrogen, trimethylamine, total volatile bases, nonprotein nitrogen, inorganic phosphate, glycogen, hypoxanthine, inosine monophosphate, and pH. The analysis was performed in triplicate.

Microbiological and Biochemical Analysis. Total aerobic plate counts were determined by the spread plate technique by placing 0.1 mL of appropriate dilution in peptone water on nutrient agar (E. Merck, Darmstadt, West Germany). At each analysis, 10 g of the sample was blended in a Waring Blendor with 90 mL of 0.1% peptone water and serial dilutions were made by using the same diluent. The plates were incubated in duplicate at 22 °C for 3–5 days.

The analyses of nonprotein nitrogen (NPN), amino acid nitrogen (AAN), inorganic phosphate (P_i), total volatile bases (TVB), and trimethyamine nitrogen (TMA-N) were performed on 5% trichloroacetic acid extract of lobster tails by blending it for 2 min in a sample to solvent ratio of 1:3.

Inosine monophosphate was determined on a neutralized perchloric acid extract prepared from 10 g of muscle by the method of Spinelli and Kemp (1966). Hypoxanthine was determined on a perchloric acid extract prepared from 10 g of muscle by using xanthine oxidase (BDH Chemicals, Ltd. Poole England) by the method of Beuchat (1973). Protein ($N \times 6.25$) (AOAC, 1975a), nonprotein nitrogen (TCA extract) (AOAC, 1975b), and ash and moisture (AOAC, 1975c) were determined according to AOAC procedures.

Lipid was extracted by the Bligh and Dyer (1959) method.

Amino acid nitrogen (AAN) was determined by the method of Spies and Chambers (1951), as modified by Cobb et al. (1973).

Trimethylamine (TMA-N) was estimated by Dyer's picric acid procedure (1945), as modified from Dyer's (1945) procedure by Hoogland (1956).

Total volatile bases was determined according to Cobb et al. (1973), and inorganic phosphate (P_i) was measured

Table I. Physical and Organoleptic Changes in Lobster Tails during Ice Storage

days in ice	raw	cooked
0	sea fresh odor; white meat; good color of whole tail meat	sweet meaty fresh seawater flavor; moist, firm fibrous (typical lobster) texture
2	very fresh odor; no change in the color of meat	sweet meaty fresh seawater flavor; moist, firm fibrous (typical lobster) texture
4	very fresh odor; no change in the color of meat	sweet meaty fresh flavor; moist, firm fibrous texture
8	fresh odor; membrane covering the tail meat slightly yellowish; no change in the color of meat	sweet flavor; moist firm texture
11	loss of fresh odor; some off-odors (acid, veg.); black coloration at the surface of meat exposed at the cut portion of tail and (claw/head); membrane covering the tail meat dark in color	some off-flavors (acid, sweetish); some softness, sponginess, dryness, and mealiness in texture
15	stale odor; sour and musty; dark black coloration at the surface of meat exposed at the cut portion of tail and head; membrane covering tail meat black; meat in the shell yellowish	definite off-flavors; Seaweedy aftertaste. definite softness, dryness and mealiness

by the method of Fiske and Subbarrow (1925).

For the measurement of pH, 10 g of muscle was homogenized in 20 mL of distilled water and the pH measured by using a Cambridge pH meter.

Glycogen was determined by the method of Montgomery (1957).

RESULTS AND DISCUSSION

The quality of lobster tails as measured by the physical changes occurring during storage in ice, together with comments on the acceptability of cooked meat, is recorded in Table I. Physical and organoleptic examination showed that definite taste changes occurred during ice storage, indicating that palatability and flavor changed only slightly during the first few days of ice storage. The flavor is described as characteristic of "fresh" lobster and is sweet, fresh seawater. This phase is followed by a period during which the lobsters no longer have the sweet fresh seawater flavor but instead is neutral "flat" tasting. During this time, no off-flavors as associated with spoilage are noted. This period is followed by another sharp change in flavor that denotes the onset of spoilage. It may be seen that lobster tails remained acceptable in ice for between 8 and 11 days. This period of storage is sufficient to permit extended periods of lobster fishing, distribution over reasonable distances, or provision of stocks in case of shortages due to bad weather. It is well-known that in the tropics, fishery products spoil very rapidly unless some form of preservation is applied, and the present study has demonstrated that the early application of ice can considerably extend the shelf life of lobster tails.

Data obtained from the sensory evaluation performed by an eight-member panel are presented in Figure 1. Each point on the graph represents an average score of flavor, texture, and appearance. Values plotted are means of at least six determinations for each evaluation date. The sensory evaluation data represent the mean score of all sensory characteristics. According to the taste panel, lobster tail retained prime quality up to 8 days after which there was a loss of characteristic flavor associated with fresh lobster. From the eighth day, the lobsters were still of acceptable quality, showing loss of characteristic flavor but without a pronounced off-flavor. From the 11th day on, a pronounced off-flavor developed and the lobster became unacceptable to the panelists. Since the tails were stored in ice simulating commercial practice, the data should be a representation and a useful elucidation of some of the biochemical changes in lobsters (*Panulirus polyphagus*) during ice storage in commercial practice.

Composition of Newly Caught Lobster. An average composition of newly caught lobster (*Panulirus polyphagus*) tail muscle and the mean level of other components are reported in Table II.

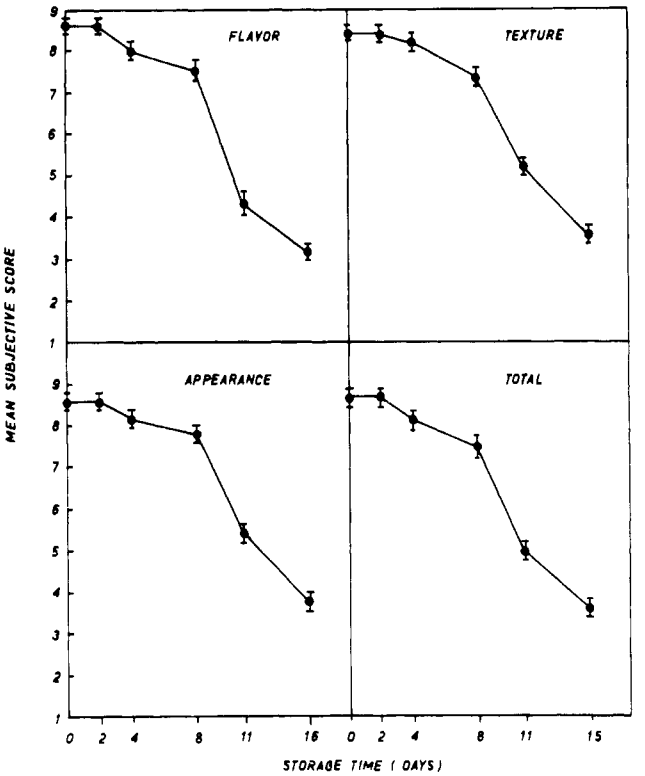

Figure 1. Mean sensory scores assigned to lobster tails stored in ice up to 15 days. Data represent the mean of six determinations on each evaluation date calculated from average scores submitted by a panel of eight members. Total sensory scores represent the combined average of flavor texture and appearance. The bar indicates standard deviations (9 = extremely good, 8 = very good, 7 = moderately good, 6 = slightly good, 5 = neither good nor poor, 4 = slightly poor, 3 = moderately poor, 2 = very poor, and 1 = extremely poor).

The percentage of moisture, protein, fat, and ash fell within the ranges reported for lobster tails. Similar to other lobsters, the Pakistani lobster (*P. polyphagus*) is a high-protein, low-fat fishery product.

Nonprotein nitrogen (Figure 2a) showed a rapid but consistent decrease during the storage period. Lobster tail muscle initially had an NPN level of 520 mg/100 g, decreased to a level of 400 mg/100 g at 8 days of storage, and rapidly decreased to 230 mg/100 g at 15 days of storage.

Nonprotein nitrogen accounts for various constituents such as lower amines, free amino acids, simple peptides, purine, and purine derivatives, etc. A decrease in NPN during storage may be a result of leaching loss due to ice-melt water and also due to the transformation by both the bacterial and autolytic enzymes. It is also likely that a decrease in NPN was due to the formation of volatile

Table II. Gross Composition and Metabolite Values of Lobster Tail Muscle

	no. of composite samples analyzed	mean ± SD
moisture, g/100 g	6	74.1 ± 0.1
ash, g/100 g	6	1.6 ± 0.02
protein, g/100 g	6	20.1 ± 0.5
lipid, g/100 g	6	4.1 ± 0.2
pH	6	6.5 ± 0.05
amino acid nitrogen (AAN), mg/100 g	6	320 ± 4.0
trimethylamine (TMA-N), mg/100 g	6	0.3 ± 0.01
total volatile bases (TVB), mg/100 g	6	22.5 ± 0.25
nonprotein nitrogen (NPN), mg/100 g	6	520 ± 3
inorganic phosphate (P_i), mg/100 g	2	295 ± 1.5
glycogen, mg/100 g	6	5.1 ± 0.1
hypoxanthine	6	nil
inosine monophosphate, μmol/g	6	3.8 ± 0.15

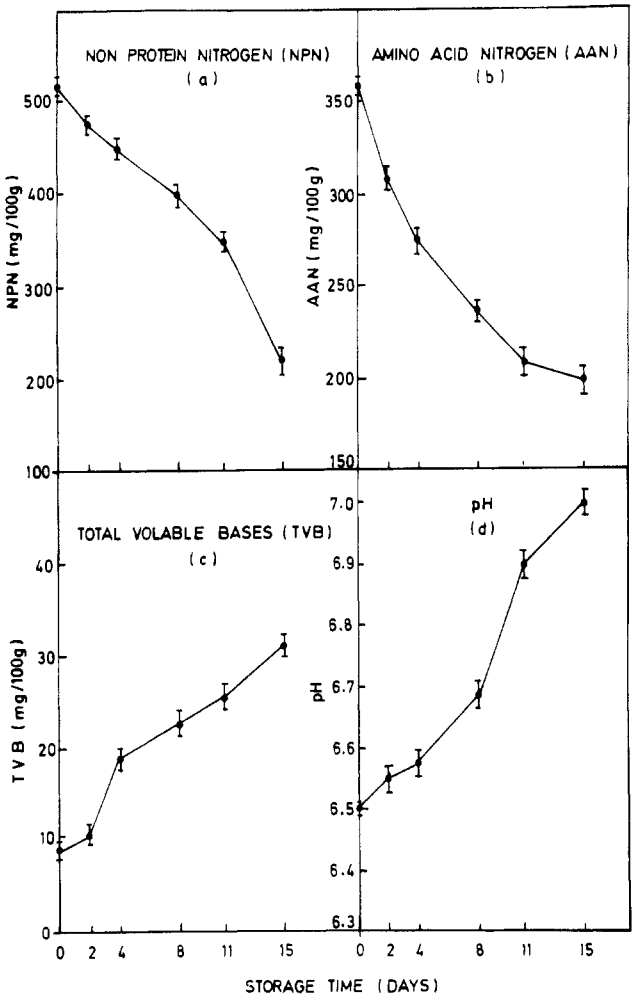

Figure 2. Changes in NPN, AAN, TVB, and pH during storage of lobster tail in ice. Each point represents the mean of six determinations at each evaluation date.

components that dissipated during storage.

Amino acid nitrogen (AAN) of the sample at zero time was noted as 320 mg/100 g and is about 62% of the total nonprotein nitrogen. Similar to NPN, AAN also decreased during storage. The initial level (Figure 2b) decreased to a level of 320 mg/100 g at 8 days of storage, followed by a slow but consistent decrease to 200 mg/100 g at 15 days

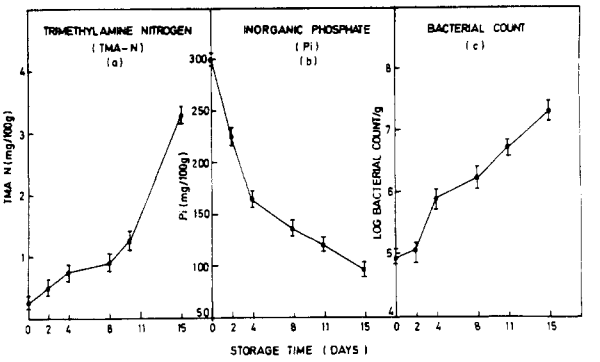

Figure 3. Changes in TMA-N, P_i, and total viable count during storage of lobster tail in ice. Each point represents the mean of six determinations at each evaluation date.

of storage. Such a high proportion of AAN has been reported for crustaceans (Velankar and Govindan, 1958a). A decrease in AAN has also been reported during ice storage of crustaceans (Velankar and Govindan, 1958b). They suggested that at least for initial stages the loss is mainly due to leaching action of ice-melt water. Unpublished work in the authors laboratory also has shown that the decrease of AAN was much less in shrimp when they were not stored in direct contact with ice. Fieger and Friloux (1954) reported a rapid decrease in AAN in ice-stored shrimp during the prime quality period followed by a more rapid decrease during spoilage.

Changes in total volatile bases (TVB) are presented in Figure 2c. The TVB level showed a rapid increase between 2 and 4 days, reaching 22.5 mg/100 g at 8 days of storage, followed by a sharp increase to 33 mg/100 g at 15 days of storage. A level of 30 mg/100 g of muscle has been considered the upper limit above which some fishery products are considered as spoiled and unfit for human consumption (Farber, 1965; Cobb and Vanderzant, 1975). This correlated well with physical observations and taste panel assessment (Table I and Figure 1). A sharp increase in TVB may be due to the increase in the number of total bacteria. A slightly off-odor, recognizable on the 11th day, and stale odor at 15 days of storage suggested that the muscle was being attacked by bacteria. Accordingly, the experiment was discontinued on the 15th day.

The pH (Figure 2d) in the muscle increased slowly during ice storage. From an initial value of 6.5, it reached 6.7 at 8 days of storage and finally reached 7.0 at 15 days of storage. According to these experiments, values of 6.7 or lower are indicative of prime-quality tail muscle, values from 6.7 to 6.9 as inferior quality but acceptable, and a pH 6.9 or above as spoiled.

The production of TMA-N (Figure 3a) followed a pattern similar to that of TVB. It showed a slow increase in early storage period followed by a sharp increase. The TMA-N, however, remained below 4 mg/100 g throughout the period of storage. From an initial value of 0.3 mg/100 g, it reached to 0.85 mg/100 g at 8 days of storage followed by a rapid increase reaching 3.4 mg/100 g at 15 days of storage. Trimethylamine analysis is often used as an index in assessing the shelf life and keeping quality of fishery products. Flores and Crawford (1973) determined that raw shrimp were shown to increase from 0.24 to 1.6 mg of TMA-N/100 g of shrimp after 8 days of storage in ice. A rapid degradation of nitrogen-containing components has been indicated during spoilage of fishery products as spoilage begins. A trimethylamine nitrogen value of 1.5 mg/100 g of unshelled, headless shrimp has tentatively been specified as an objective index of spoiled shrimp (Baily et al., 1956).

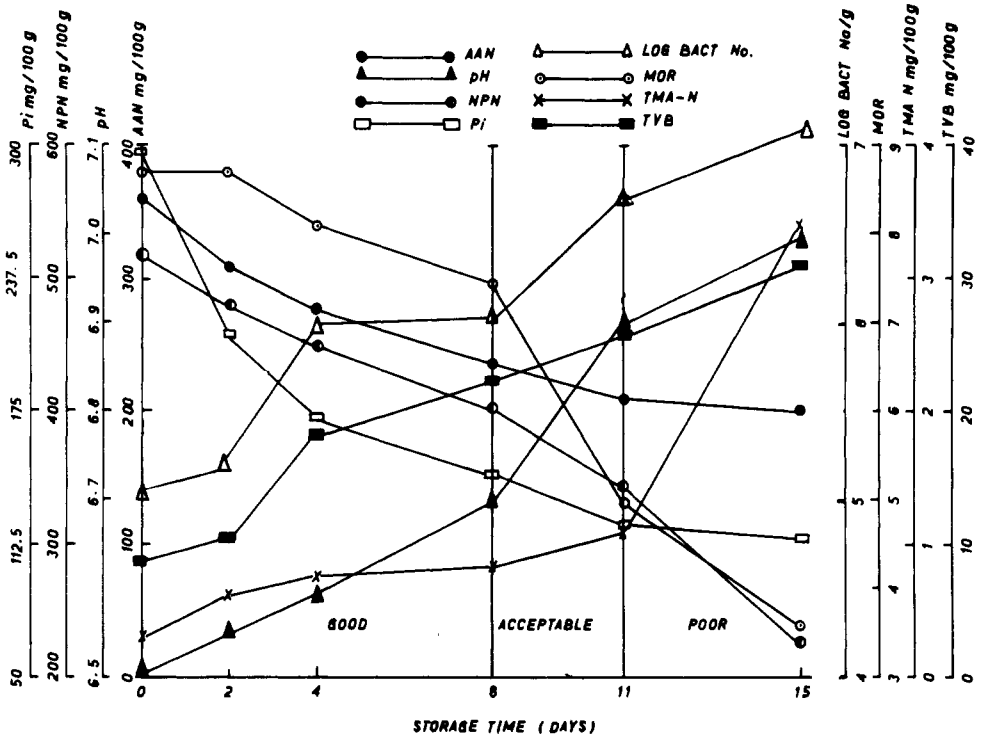

Figure 4. Correlation between quality grading, i.e., mean organoleptic response (MOR), and some of the chemical changes occurring in lobster tail during storage in ice. Scores (MOR): 8.7–7.4, grade I, prime quality, sweet, fresh, seawater; 7.3–5.0, grade II, acceptable, neutral, flat tasting; 4.9 and below, grade III, unacceptable (poor), off-flavor.

As already noted, lobster tails retain prime quality up to 8 days of storage, between 8 and 11 days they show incipient spoilage, and after 11 days advanced spoilage is evident. Perhaps a TMA-N value of 1.5 mg/100 g of muscle may be indicative of spoilage of lobster tail.

Inorganic phosphate (Figure 3b) levels rapidly decreased in the early part of the storage. From an initial value of 295 mg/100 g P_i decreased to 173.7 mg/100 g at 4 days of storage. The level then gradually decreased to 118.8 and 95.6 mg/100 g at 11 and 15 days of storage, respectively. This rapid decrease in inorganic phosphate level is an unusual characteristic of lobster tail muscle. A similar decrease has also been reported for ice-stored shrimp (Baily et al., 1956; Flick and Lovell, 1972). As may be expected, inorganic phosphate should increase in the muscle with the dephosphorylation of sugar phosphates and nucleotides. In fish and rabbit muscle an increase in inorganic phosphate has been reported. The loss in lobster may have been due to leaching during storage.

The results of total viable bacterial counts are presented in Figure 3c. After a relatively short lag phase, a fairly rapid and consistent bacterial growth was observed after 2 days. The counts did not increase much during storage. However, the pattern of bacterial growth appears to have some relationship with the shelf life. Lobster tails were considered to be of prime quality up to 8 days when the bacterial count was close to 10^6/g. From 11 days on the tails were unacceptable and the bacterial count was close to 10^7 or above. A 2 log increase was obtained during the entire storage period of 15 days. The susceptibility of the bacterial flora of tropical fish to low temperature probably explains the relatively slow increase in bacterial populations during ice storage.

The initial bacterial counts (9×10^4/g) found in this study appear to be high for zero day. Sidhu et al. (1974b) reported a zero day count close to 10^3 and 10^4/g for lobster (*J. novae hollandiae*). The initial high counts may have been due to species difference and poor sanitary handling of lobster after havest.

Table III. Correlation Coefficients between Mean Organoleptic Score and Other Parameters during Ice Storage of Lobster

mean organoleptic response (MOR) vs.	correlation coefficients (r)
NPN	0.92
TMA	−0.84
AAN	0.76
TVB	−0.90
P_i	0.82
pH	−0.94
bacterial count	−0.94

Bacterial counts have been used as an index of sanitary quality. High bacterial counts are unacceptable but do not always indicate the extent of loss of quality or spoilage. This is caused by differences in biochemical activities of the individual bacterial species, particularly on the proteins and lipids of seafood. This study did not include the classification of microbial flora. Further work should be carried out on this aspect.

Figure 4 represents a comparison between the results of taste panel assessment and chemical and microbiological data obtained during the storage of lobster tail. It may be noted that lobster tails retain prime quality up to 8 days of storage; between 8 and 11 days they show incipient to advanced spoilage, and after 11 days advanced spoilage is evident. It is also clear that the decrease in taste scores are closely related to various objective changes that take place during spoilage. A small variation in various changes occurs between 0 and 8 days, a relatively large variation between 8 and 11 days, and largest variation after 11 days of storage.

Correlation coefficients (r) were calculated between mean organoleptic response (MOR) and chemical parameters. Although most of the objectively measured changes correlated with MOR (Table III), the correlation coefficient (r) ranged from 0.76 to 0.94, giving coefficients of determination (r^2) of 0.577–0.883. Consequently, some of the objectively measured changes may be useful indicators of

sensory quality, but their practicability is questionable because a correlation coefficient indicates only an association and not a cause-and-effect relationship. More data are required to prove the practicability of these tests.

From numerous tests and data presented in this study, the following guidelines are suggested:

grade quality	I prime	II acceptable	III poor
days in ice	0-8	9-11	>11
MOR	8.7-7.4	<7.4-5.0	<5
NPN, mg/100 g	520-400	<400-345	<345
AAN, mg/100 g	360-230	<230-210	<210
TVB, mg/100 g	9.0-22.5	>22.5-26.0	>26.0
TMA-N, mg/100 g	0.3-0.7	>0.7-1.1	>1.1
P_i, mg/100 g	295-144	<144-118	<118
pH	6.5-6.7	>6.7-6.9	>6.9
TPC	9×10^4-1.4×10^6	$>1.4 \times 10^6$-7×10^6	$>7 \times 10^6$

Our studies indicate that if the lobster shell on tails are stored in ice, these could be kept in good condition for up to 8 days and in an acceptable condition up to 11 days.

Registry No. TMA-N, 75-50-3; Pi, 14265-44-2; NPN, 7727-37-9; glycogen, 9005-79-2; hypoxanthine, 68-94-0; inosine monophosphate, 131-99-7.

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Preliminary Nutritional and Chemical Evaluation of Raw Seeds from *Mucuna solanei*: An Underutilized Food Source

Oladapo A. Afolabi,* Bolanle A. Oshuntogun, Stephen R. Adewusi, Omololu O. Fapojuwo, Fola O. Ayorinde, Felix E. Grissom, and Olusegun L. Oke

One method, which has often been negelected, of alleviating malnutrition in tropical Africa is the use of underutilized food sources. One such abundant, underutilized, but potential food source is *Mucuna solanei* seeds. Raw seeds of *M. solanei* were analyzed for proximate composition, amino acid profile, mineral content, lipid classes, fatty acid spectrum, and feeding trial. The crude protein content was 24%, fat 6.5%, crude fiber 5.3%, and ash 3.0%. The seeds appear to be a rich source of minerals, most especially calcium. The chemical score is generally low; however, lysine and phenylalanine are high, 198.66% and 270.77%, respectively. The major lipid class is triglycerides. The major fatty acid is C16:0. A major setback is that all rats fed the raw seeds died within 72 h of commencement of the experiment.

It is now generally accepted that few of the challenges facing the Third World countries are larger or more important than the problem of hunger and malnutrition. The prevention of malnutrition in rapidly expanding populations such as Nigeria is a task of staggering proportions. Several countries are advocating different nutritional policies to augment available food through the introduction of high-yielding seeds, pest control, and preservation. However, one method that has often been neglected is the use of underutilized food sources.

Mucuna solanei, studied here, is widespread in the tropics and exists in thick forests near villages (or farmlands abandoned for 2-3 years), in forests along rivers or streams, and also along footpaths and walks of rural areas.

Department of Chemistry, University of Ife, Ile-Lfe, Nigeria (O.A.A., B.A.O., S.R.A., O.O.F., and O.L.O.), Department of Chemistry, Howard University, Washington, DC 20059 (F.O.A.), and Department of Physiology and Biophysics, Howard University, Washington, DC 20059 (F.E.G.).

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