Comparison of Sensory Characteristics and Biochemical Parameters in Commercial Frozen Prawns

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Commercial samples of frozen shrimp of different styles of presentation and size grades were tested for sensory, physical (cooked yield and pH) and biochemical characteristics (moisture, total nitrogen, water extractable nitrogen, nonprotein nitrogen, alpha amino nitrogen, total volatile nitrogen and trimethylamine nitrogen). The test results are compared and correlated. The order of preference of the samples were HL>PUD>P & D. There was significant correlation between sensory score of cooked sample and WEN, NPN and α - NH_2-N values. TVN and TMA-N did not exhibit any correlation with sensory score. It is inferred that in quality measurement of frozen shrimps of commerce the quantity of water soluable components and the total dry matter can be used to support the sensory test results.

Frozen shrimp, the most important seafood item of export from India has been subjected to regular Preshipment Inspection since 1965, based on physical and sensory characteristics in the early periods followed by inclusion of bacteriological characteristics also since early 1970's. Bacteriological quality of frozen shrimps has been the subject of several studies (Pillai & Lekshmy, 1961; Lekshmy *et al.,* 1962; Mathen *et al.,* 1964; Lekshmy & Pillai, 1964; Pillai *et al.,* 1965a; Gopalakrishna Iyer *et al.,* 1973 and Varma *et al.,* 1985). However, published information on the biochemical characteristics of this product and how it correlated with the other quality parameters is scanty (Wong, 1983). In the international trade, there is a tendency towards more objectivity in quality measurement, thus necessitating more objective methods of quality evaluation. In shrimp processing for freezing, as practised in this country there is always a prefreezing ice storage period in addition to several washing steps which cause leaching of soluble components. The leaching process has been intensely studied by Govindan (1962a, b & 1969), Pillai *et al.* (1965 b) and Mathen (1983). Govindan (1969) has further shown that the levels of water extractable proteins and α-amino nitrogen are useful indices of quality of iced prawns. Mathen (1983) has shown that the dry matter content is a factor to be included in quality assessment of commercial frozen shrimp meat. The leaching process, if allowed to continue may cause a stage of 'no flavour' in the product. In this paper an attempt is made to compare and correlate the sensory quality of frozen shrimp from the industry with certain biochemical and physical parameters.

Materials and Methods

Commercial frozen prawns of different forms, namely, headless shell on (HL), peeled (PUD) and peeled and deveined (P & D) and grades were procured from the shrimp processing factories in Cochin over a period of two years. A total of 142 samples had been examined for the study. The frozen material kept in water proof polythene bags was thawed in running water at room temperature, drained and weighed (IS: 2237, 1971). Sensory chatacteristics of the thawed material was assessed by an expert panel of four members, mainly based on discolouration, deterioration, black spot on shell or meat, odour etc. and an overall score was given (RS). One portion of the thawed material was cooked in 3% brine for about 5 min, drained, weighed and subjected to taste panel study. Sensory score of the cooked sample (CS) was mainly based on odour, texture and flavour. The scoring was according to a 10 point hedonic scale

in both cases. The mean of the individual score was calculated. A third portion of the material was homogenised and was used for the estimations of moisture/solid content, pH of the muscle and for other biochemical parameters. Control samples were prepared in the laboratory from fresh prawns and frozen blocks of 400 g each were made. The sensory and biochemical studies were carried out on these samples after a few days of storage at — 20 ± 1°C as in the case of commercial samples.

Moisture/solid content was determined by drying the homogenised samples in a hot air oven at 100 ± 2°C over night. pH was measured on a suspension of 4 g of minced meat in 40 ml of distilled water. Total nitrogen (TN), water extractable nitrogen (WEN) and non-protein nitrogen (NPN) were determined following AOAC (1975) procedures and the free ∝ amino nitrogen by the method of Pope and Stevens (1939). Total volatile base nitrogen (TVBN) and trimethylamine nitrogen (TMA-N) were determined by the microdiffusion method of Conway (1947) using trichloroacetic acid (TCA) extract of the muscle. The data were statistically analysed.

Results and Discussion

The results of the sensory scores and biochemical analysis of frozen shrimp (HL, PUD and P & D forms) from the industry are presented in Tables 1 to 3. Two or three commercial grades were clubbed together and is presented in the Table. There was considerable loss of solids, total nitrogen (TN), water extractable nitrogen (WEN), non-protein nitrogen (NPN) and free alpha-amino nitrogen in commercial frozen prawns compared to the control; the losses being in the order HL < PUD < P & D. The sensory scores also declined synchronising with the fall in the biochemical components.

In general, frozen HL prawns had higher sensory scores (CS) than the other two forms. Although, the average raw score (RS) value for PUD prawns was similar to that of HL prawns, the taste panel study marked low values for CS. The relatively high value for RS in PUD prawns indicated that the material was apparently of good quality. However, as the pre-freezing leaching effect was highest in PUD and P & D material owing to the large exposed surface area (Govindan, 1962a), much of the soluble flavour bearing components must have been lost and hence indicated low values for cooked flavour score.

The muscle pH did not vary widely in the three forms of frozen prawns and the values were quite similar. Moisture level was lowest in HL prawns and increased in the order of PUD and P & D. The percentage

Table 1. *Sensory and biochemical characteristics of commercial frozen HL prawn (Mean value and standard deviation, given in brackets)*

Grade count/lb	Sample No.	RS	CS	pH	Moisture %	TN %	WEN mg/100g	NPN mg/100g	∝NH_2N mg/100g	TVN mg/100g	TMAN mg/100g
11–25	8	7.29 (0.49)	6.93 (0.45)	7.52 (0.11)	78.42 (2.59)	2.931 (0.22)	1224 (129.6)	633.3 (73.6)	226.0 (14.5)	40.67 (4.7)	3.97 (1.1)
26–50	9	7.00 (0.50)	6.67 (0.50)	7.62 (0.19)	80.20 (1.02)	2.745 (0.16)	1036.8 (180.7)	517.2 (118.7)	194.1 (61.5)	38.84 (6.9)	4.20 (3.13)
51–70	10	6.44 (1.13)	6.63 (1.3)	7.86 (0.15)	82.07 (1.8)	2.517 (0.23)	889 (274.1)	417.8 (171.1)	180.6 (90.8)	32.0 (10.7)	2.71 (2.4)
71–90	6	5.5 (1.3)	6.50 (1.50)	7.88 (0.10)	81.37 (1.50)	2.662 (0.15	985.3 (145.8)	454.5 (104)	214.6 (62.4)	46.15 (7.0)	5.25 (1.36)
Overall mean ± S.D.		6.6 (1.1)	6.6 (0.8)	7.66 (0.20)	80.36 (2.36)	2.716 (0.24)	1024.4 (208.6)	505.3 (136.5)	204.7 (70.2)	37.13 (8.98)	3.86 (2.4)
Control sample (61–90)		10.0	10.0	7.40 (0.2)	76.03 (1.1)	3.308 (0.14)	1659.0 (70.1)	828.0 (44.6)	456.8 (25.4)	42.30 (7.56)	2.8 (1.6)

Table 2. *Sensory and biochemical characteristics of commercial frozen PUD prawns, Mean value and standard deviation, given in brackets*

Grade count/lb	Sample No.	RS	CS	pH	Moisture %	TN %	WEN mg/100g	NPN mg/100g	α-NH_2-N mg/100g	TVN mg/100g	TMA-N mg/100g
90–130	8	6.2 (1.6)	6.1 (1.4)	7.50 (0.18)	83.41 (2.01)	2.426 (0.25)	664.56 (196.7)	298.4 (125.0)	132.89 (78.5)	29.1 (11.64)	4.60 (2.24)
100–200	7	6.5 (1.0)	6.8 (0.8)	7.68 (0.3)	83.85 (1.7)	2.236 (0.20)	732.2 (182.6)	290.9 (133.8)	77.4 (34.5)	28.70 (12.90)	4.76 (3.9)
200–300	4	6.0 (0.6)	6.5 (0.6)	7.58 (0.50)	84.39 (0.8)	2.305 (0.10)	686.0 (90.3)	266.0 (35.5)	74.38 (28.6)	23.90 (8.8)	5.36 (1.5)
300–600	19	6.4 (1.2)	5.3 (0.7)	7.60 (0.21)	84.91 (1.21)	2.118 (0.18)	562.47 (64.45)	191.33 (76.46)	60.25 (29.1)	18.12 (5.4)	2.22 (1.54)
Broken (Thelly)	11	7.0 (1.0)	4.0 (1.1)	7.71 (0.29)	86.39 (0.70)	1.969 (0.12)	437.9 (132.9)	110.1 (30.3)	26.69 (7.3)	13.92 (3.7)	2.23 (1.3)
Overall mean S.D.		6.7 (1.1)	5.4 (1.5)	7.60 (0.23)	84.52 (2.1)	2.168 (0.26)	579.3 (184.0)	205.5 (110.0)	78.03 (58.5)	20.36 (8.7)	3.07 (2.5)

Table 3. *Sensory and biochemical characterustics of commercial frozen P & D, mean value and standard deviation, given in brackets*

Grade count/lb	Sample No.	RS	CS	pH	Moisture %	TN %	WEN mg/100g	NPN mg/100g	α-NH-N_2 mg/100g	TVN mg/100g	TMA-N mg/100g
71–130	12	5.86 (1.34)	5.36 (0.98)	7.43 (0.20)	84.15 (1.06)	2.262 (0.15)	495.4 (128.9)	231.6 (70.8)	65.39 (26.1)	25.55 (11.9)	2.90 (1.69)
130–200	18	6.20 (1.1)	5.70 (0.90)	7.38 (0.22)	84.65 (1.58)	2.188 (0.14)	564.5 (183.6)	215.6 (66.8)	69.04 (17.9)	20.39 (6.8)	2.31 (1.8)
200–300	13	6.0 (1.1)	5.1 (0.80)	7.46 (0.32)	85.64 (1.04)	2.073 (0.18)	480.3 (129.9)	178.2 (88.0)	49.75 (16.8)	18.76 (8.7)	3.5 (1.6)
300–500	17	5.3 (1.4)	4.9 (0.9)	7.74 (0.33)	85.78 1.12	2.010 (0.11)	383.9 (95.0)	154.9 (44.4)	56.16 (20.6)	18.34 (5.5)	2.57 (1.9)
Overall mean $\pm$ S.D.		5.9 (1.3)	5.23 (1.0)	7.50 (0.30)	84.91 (1.67)	2.129 (0.21)	486.9 (156.9)	194.1 (72.1)	60.15 (26.6)	20.51 (8.3)	2.80 (1.6)

increase in moisture content is given in Table 4. The moisture content also showed an increase with count in all the three forms of commercial frozen prawns (Table 1 to 3).

The biochemical constituents, viz. TN, WEN, NPN and α NH_2-N declined in HL, PUD and P & D material, the percentage loss being in the order HL $\ll$ PUD $<$ P & D. More than 75% of the NPN fractions were lost in commercially frozen PUD and P & D prawns. Again, these two forms of the commercial product caused 65–70% loss in WEN (Table 4). Free α - NH_2-N level reached half of its value in HL prawns and around 15% in the other two forms. The loss of the various nitrogenous materials was higher in small grade prawns in all the three forms of the material. As a result of these loss, the prawns progressively lost its characteristic flavour and concomitantly a decrease in CS values also could be seen (Tables 1 to 3).

The TVN and TMA-N values did not follow any pattern with sensory scores in the products, probably due to leaching effect. As in the case of other chemical constituents, the TVN values were also higher in HL prawns compared to PUD and P & D varie-

ties. This again indicates that the pre-freezing leaching effect would be minimum in HL forms. Higher values for TVN in control and HL frozen prawns as observed in the present study were also reported by earlier workers (Susamma *et al.*, 1962; Pillai *et al.*, 1965 b). The results showed that the values for TVN and TMA-N were quite erratic and did not indicate any spoilage pattern (Pillai *et al.*, 1965b; Govidan, 1962a).

The dry matter content in HL prawns was the highest (19.45%) and ranged between 16.38 and 25.40%. In PUD and P & D prawns the dry matter content varied from 12.29 to 21.72% and 12.63 to 17.56% and the mean values were 15.20 and 14.88% respectively. The PUD and P & D prawns make a loss of 37% of the total solids (Table 4) The solid loss greatly affected the sensory quality. Mathen (1983) reported a maximum loss of solids in P & D prawns as 40% and the material had 'no flavour'. The cooked yield also decreased in the product in the order HL < PUD < P & D. The HL form gave an average cooked yield of 61.34%, whereas the values for PUD and P & D varieties were 53.50% and 50.87% respectively.

From the results, it is clear that the levels of soluble nitrogenous material are significantly related to sensory quality of the frozen prawns. When more than 70% of the NPN fractions are lost as observed in the present study (Table 4) in P & D and PUD material; the prawns lost all its sweet flavour and rated a low sensory score.

Table 4. *Percentage loss of total solids, TN, WEN, NPN and ∝-NH_2-N and increase of water content in different types of commercial frozen shrimp*

Characteristics	HL	PUD	P&D
Total solids	18.96	35.50	37.08
TN	17.90	34.46	35.64
WEN	38.30	65.08	70.65
NPN	42.61	76.70	77.99
∝-NH_2N	55.19	82.92	86.83
Moisture (increase)	5.70	11.17	11.72

Table 5. *Correlation coefficients (r) and level of significance* for interrelationships between sensory scores and other physico-chemical parameters in commercially frozen prawns*

	pH	Moisture	TN	WEN	NPN	∝-NH_2-N
HL						
RS	−0.5149[b]	−0.5058[b]	0.5306[b]	0.6371[a]	0.6260[a]	0.6158[a]
CS	ns	−0.5028[b]	0.5142[b]	0.7137[a]	0.6383[a]	0.5790[b]
Count	0.5292[a]	0.4375[c]	−0.3735[c]	ns	ns	ns
Dry matter	−0.6123[a]	—	0.8629	0.7050[a]	0.7631[a]	0.6097[a]
PUD						
RS	ns	ns	0.2982[c]	ns	0.3252[c]	0.3959[b]
CS	ns	−0 6348[a]	0.5827[a]	0.7836[a]	0.6652[a]	0.6194[a]
Count	ns	−0.4706[b]	−0.5673[a]	−0.3623[b]	−0.4904[a]	−0.5199[a]
Dry matter	ns	—	0.9163[a]	0.6777[a]	0.7579[a]	0.8413[a]
P & D						
RS	−0.5170[a]	ns	ns	ns	ns	ns
CS	−0.3183	ns	0.3095[c]	0.5143[a]	0.5011[a]	0.5605[a]
Count	0.4673[a]	−0.4953[a]	−0.5637[a]	−0.4345[a]	−0.4234[b]	ns
Dry matter	ns	—	0.9157[a]	0.7613[a]	0.8403[a]	0.8801[a]

*Level of significance, a=at 0.1%, b=1%, c=5% and ns=not significant, TVN and TMA-N did not indicate any significant correlation with RS, CS, count or dry matter content.

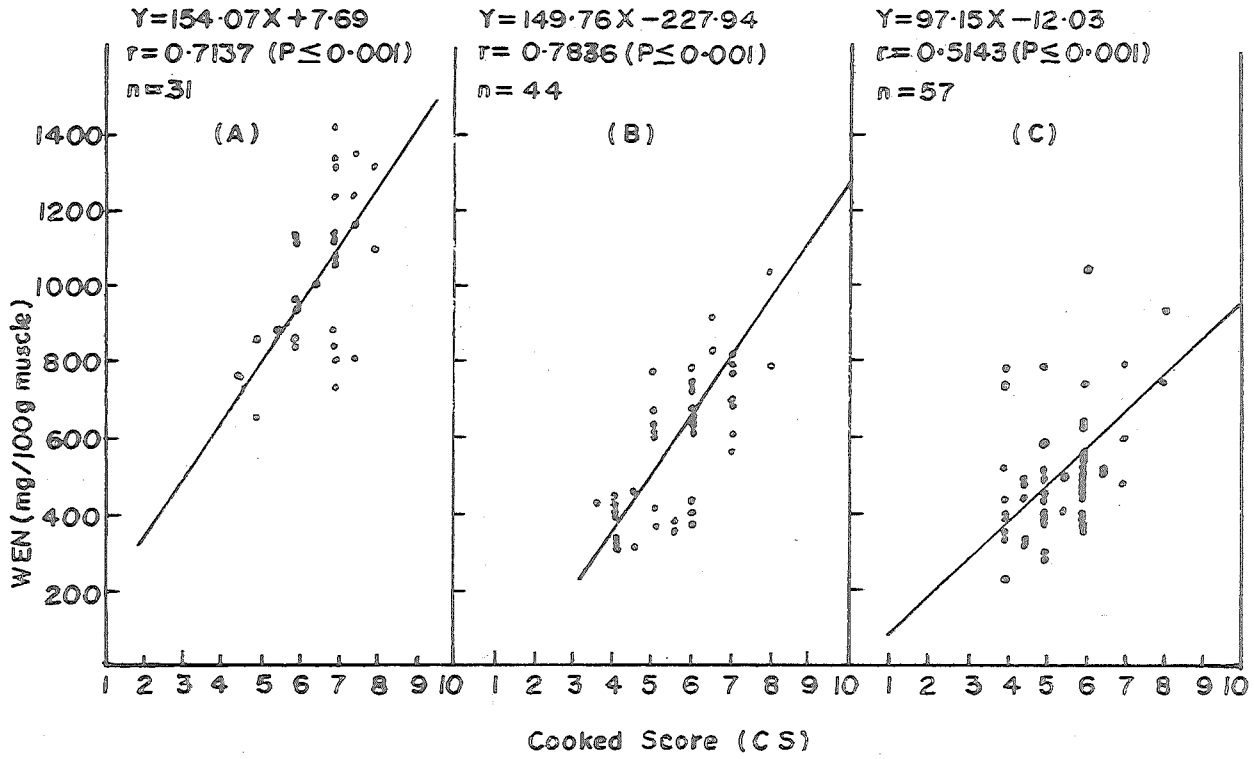

Fig. 1. Relationship between cooked score (CS) and WEN in HL (A), PUD (B) and P & D (C) frozen prawns

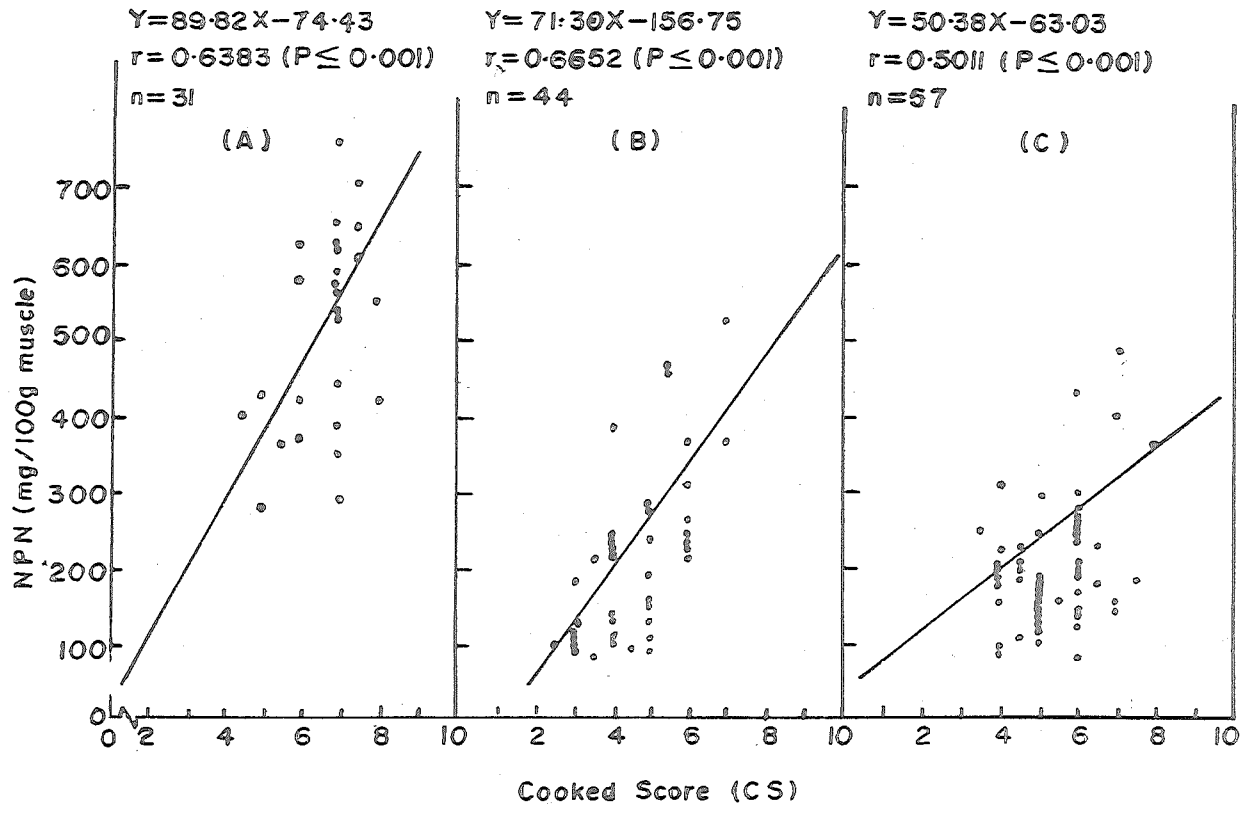

Fig. 2. Relationship between cooked score (CS) and NPN in HL (A), PUD (B) and P & D (C) frozen prawns

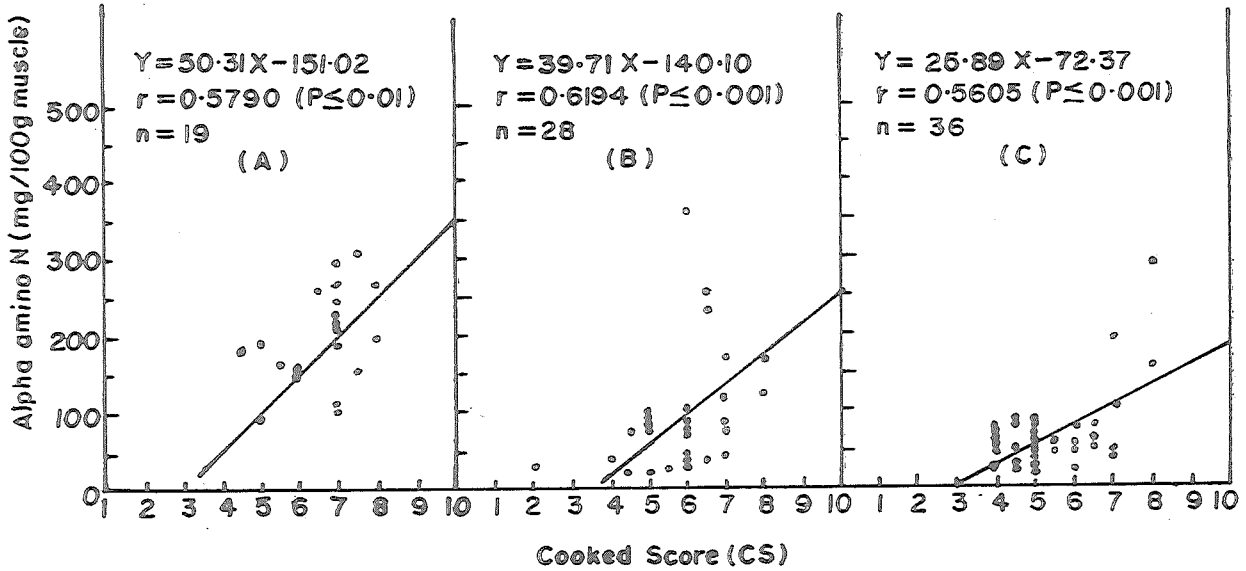

Fig. 3. Relationship between cooked score (CS) and alpha amino nitrogen in HL (A), PUD (B), and P & D (C) frozen prawns

In order to compare the relationship between sensory quality and other biochemical, parameters, the data were subjected to statistical analysis. The correlation between sensory scores and biochemical parameters were worked out. The correlation matrix for sensory scores, dry matter content, cooked yield and other biochemical parameters are shown in Table 5. In general the cooked flavour score showed high positive correlation ($P \leq 0.001$) with biochemical parameters like WEN, NPN and α NH_2N values in all the three forms of frozen prawns (Table 5). Regression lines were drawn (in the form $Y=aX+B$) for CS and biochemical parameters and are given in Fig. (1 to 3) along with the linear equations; where X= sensory score and Y=the biochemical component. CS and TN were significant at 1 and 5% level in HL and PD varieties respectively. The RS values in HL prawns showed high positive correlation with biochemical parameters ($P \leq 0.001$). However, in the other two forms, no significant correlation could be found between these parameters in most cases (Table 5).

Count showed significant negative correlation with biochemical parameters in both PUD and P & D prawns ($P \leq 0.001$ to 0.01) except for α- NH_2-N in P & D material. However, in HL prawns only pH, moisture and TN showed some association with count (Table 5). The negative correlations of biochemical parameters with count, in the case of PUD and P & D prawns indicated that the leaching of the soluble materials were greater in smaller size grades, a consequence of larger surface area of these material. In HL prawns, the shell protects the leaching process to a larger extent.

Dry matter content in all the three forms of material exhibited high positive correlation ($P \leq 0.001$) with the biochemical parameters like TN, WEN, NPN and α-NH_2-N (Table 5). It seemed that the dry matter content along with sensory evaluation can help to provide valuable information about the quality of the frozen prawn product and its pre-freezing history. pH did not assist much in the quality assessment of the frozen material although some relations were established with sensory scores (Table 5).

The results showed that the biochemical parameters, especially the levels of water extractable nitrogen, non-protein nitrogen and α-amino nitrogen in commercial frozen prawns would greatly help to predict the equivalent sensory quality (flavour scores) on the basis of the regression equations.

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