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ASSESSMENT OF CARAMOTE PRAWN *(PENAEUS KERATHURUS)* PROXIMATE VALUE AND FRESHNESS UNDER ICE STORAGE

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In this study, the flesh yield and proximate contents of caramote prawn, *Penaeus kerathurus,* were researched depending on sex and seasons. Furthermore, prawns were divided into two groups for freshness assessments at two different times. The first group of prawn was completely wrapped with the stretch film and aluminium foil and stored at room temperature. The second group was placed in water with ice and stored at 4±1 °C (ice storage). The shelf-life of *P. kerathurus* was determined. Trimethylamine-nitrogen (TMA-N) and pH were analysed to determine biochemical quality and total mesophilic count (TMC) was measured to determine the microbial quality. In addition, sensory analyses were also carried out. The flesh yield of *P. kerathurus* was on average 52%. It was found that percentages on average moisture, lipid, protein, and ash contents in *P. kerathurus* were 76.27%, 1.63%, 16.52%, and 1.98%, respectively, and these values changed depending on the season ($P<0.01$). Increases in TMA-N, pH, TMC values and changes in the sensory parameters were found statistically significant ($P<0.05$) in prawns throughout storage. According to sensory, chemical, and microbial analyses, it was found that shelf-life of *P. kerathurus* wrapped with aluminium foil and stretch film and stored at room temperature was 1 day. The shelf-life of *P. kerathurus* for ice storage was 9 days.

Keywords: shrimp, chemical composition, flesh yield, quality, shelf-life

Shrimp fishery is economically one of the most important fields in the world. Different species of shrimp are caught *(Penaeus kerathurus, P. semisulcatus, P. japonicus, Metapenaeus stebbingi, M. monoceros, Parapenaeus longirostris, Trachypenaeus curvirostris, Melicertus hathor, Aristaeomorpha folicea, and Plesionika heterocarpus)* which have commercial value. *P. kerathurus, P. semisulcatus,* and *P. japonicus* among all species are the most common in Turkey (Bayhan et al., 2005). The total amount of prawn caught in Turkey was 4668 tons in 2008 and 2050 tons of this amount were from the Mediterranean Sea (Turkstat, 2008).

Seafood is an excellent source of high quality protein that contains sufficient amounts of most of the essential amino acids required in the human diet, but it spoils very fast. After catch, prawn spoil rapidly unless immediately iced because of the close relation between temperature and deterioration. So, prawn is delivered to the processing plant in ice to cool it down (Huidobro & Lopez-Caballero, 2002; Kanduri & Eckhardt, 2002). Blackspot or melanosis in prawn is one of the major problems in the industry and a natural post-mortem phenomenon that involves the action of an enzymatic complex in the presence of oxygen (Gökoğlu, 2004). Storage in water with ice, where the presence of the oxygen is limited, inhibits melanosis in raw prawns (Karthikeyan et al., 1999). Prawns are generally kept at the retail seafood markets in the water with ice and when the market is closed, they are stored in chilling rooms at 0 to 4 °C during the night in Turkey. Prawns are generally consumed in Turkey as fresh, salt-boiled, canned, smoked, and frozen products (Bayizit et al., 2003).

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The aim of this study was to determine the flesh yield and proximate contents of *Penaeus kerathurus* (caramote prawn) caught in the Gulf of Antalya. In addition, the present paper reports on meat quality assessment of prawn at room temperature, as consumers transport it from market to home, and with ice storage, as at the retail seafood markets, by evaluation of chemical, microbial, and sensory changes. Thus, the shelf-life of prawn on the retail seafood markets on account of acceptability for human consumption was determined.

1. Materials and methods

1.1. Sample preparation

Caramote prawns, *Penaeus kerathurus* (Forsskål, 1775), were caught during one year in the Gulf of Antalya in Mediterranean Sea, Turkey. Totally, 61 animals, 31 female and 30 male, were used to calculate the flesh yield of prawns at March 2004. Mean total weight and length of female individuals were 29.01±2.97 g and 15.91±1.39 cm, of male individuals 20.65±3.03 g and 14.20±2.97 cm, and of total 22.80±6.10 g and 14.48±1.31 cm, respectively. The prawns were then transported immediately to our laboratory in polystyrene boxes under ice. Edible parts were separated from the processing by-products (cephalotorax, abdominal segments, and telson) and weighed, and a calculation was made on the percentage of edible parts to the body weight. For proximate analysis, 1 kg sample was used once in two months during one year. For the quality analysis, 10 kg samples were used and two conditions were prepared in May–June 2005. For the first condition, prawns were completely wrapped with the stretch film and aluminium foil and stored at the room temperature, approximately 25±10 °C for 2 days. For the second condition, prawns were placed in water with ice (ice storage) and stored at 4±1 °C for 10 days. The shrimp-to-water with ice ratio was around 1:2. Ice was added to the boxes as required. Two samples from pooling 500 g homogenate of shrimp meat were taken daily for both proximate and quality analysis. All analyses were performed in two replicates.

1.2. Proximate analysis

The proximate composition of caramote prawn meats were determined according to the Official Methods of Analysis. Moisture content was determined according to the Official Method (A.O.A.C., 2005a). Crude protein content (N×6.25) was calculated using the Kjeldahl method (A.O.A.C., 2005b). Lipid (fat) content was determined according to the Soxhlet method (A.O.A.C., 2005c). Crude ash (inorganic matter) was determined according to (A.O.A.C., 2005d).

1.3. Chemical analysis

pH: The pH value was measured with a pH-meter (Hanna Instruments, 211, USA), the glass electrode being applied directly to the flesh.

Trimethylamine nitrogen: TMA-N was measured according to the method of Schormüller (1968). Twenty-five grams of homogenized samples were weighed, blended with 75 ml of 7.5% trichloroacetic acid solution, and filtered. The blended solution was fixed with formaldehyde (20%). Four millilitres of the extract was transferred into test tubes and 1 ml formaldehyde (20%), 10 ml anhydrous toluene, and 3 ml KOH solution (50%) were added. The tubes were shaken and 5 ml toluene layer was pipetted off to another tube. Five

ml picric acid working solution (0.02%) was added. The contents were mixed and transferred to a spectrophotometric cell. Absorbance at 410 nm against the blank was measured. At the same time, standards were prepared and measured. Results were expressed in milligrams of TMA-N per 100 mg of sample.

1.4. Microbiological analysis

Twenty-five grams of the samples were weighed aseptically and homogenized with 225 ml of pepton water diluent (Merck, Cat No. 107228, Darmstadt, Germany) in a Stomacher (Stomacher, IUL Instrument, Barcelona, Spain). Further decimal dilutions were made with the same diluent. The total mesophilic count (TMC) was determined on Plate count agar (PCA, Merck) by the pour plate method, and incubated at 37 °C for 48 h according to Harrigan and McCance (1976).

1.5. Sensory evaluation

Sensory analyses were carried out as described by Yoshikawa (1969). Prawns were assessed by a panel of 10 internally trained members of the Fisheries Faculty, University Akdeniz, using a 5-point hedonic scale every day during the 10 days of storage period. The parameters evaluated by the assessors on the prawns: appearance and odour (1: dislike extremely, 2: dislike moderately, 3: neither like nor dislike, 4: like moderately, and 5: like extremely).

1.6. Statistical analyses

One-way analysis of variance of data was carried out using the SPSS 13 for Windows software package (SPSS Statistical Software, Inc., Chicago, IL, USA). The difference between pairs of means was resolved by means of confidence intervals using Tukey's tests, *t*-test, and correlation; the level of significance was set at $P<0.05$.

2. Results and discussion

The mean flesh yield value of prawn was determined as 52.43±3.73% (51.89±4.63% for female and 53.16±1.79% for male) (Table 1). There was no statistically important difference between female and male prawns for either the flesh yield or proximate content ($P>0.05$). The flesh yield value was similar to that reported by Ngoan and co-workers (2000) and Diler and Ataş (2003).

The proximate contents of prawn samples statistically changed depending on the seasons ($P<0.01$) (Table 1). The average moisture content of fresh prawn was 76.22±2.97% in this study. The average of crude lipid content of prawn was 1.59±0.89%. The highest level of lipid in female and male prawns was observed in winter, and autumn and winter, respectively. The fresh prawn's average crude protein content was 14.48–19.12%. The highest level of protein in female and male prawns was obtained in summer and autumn, and summer, respectively. The average crude ash content was 1.23–2.87%. The highest level of ash in both female and male prawns was obtained summer. The proximate contents of prawn were similar to that reported by De Moura and co-workers (2002), Lopez-Caballero and co-workers (2007), Cadun and co-workers (2008), and Ünlüsayin and co-workers (2010).

Most of the quality parameters of prawn stored at the room temperature and under ice storage have shown good correlation with the days of storage ($P<0.01$) (Table 2).

Table 1. The proximate contents of *P. kerathurus* by seasons along the year

Seasons	Sex	Moisture (%)	Crude lipid (%)	Crude protein (%)	Crude ash (%)	Carbohydrate (%)	Energy (kcal/100 g)
Autumn	F	79.21±1.81^{a}	1.06±0.91^{a}	17.74±0.26^{a}	1.85±0.50^{a}	0.14±0.13^{a}	80.45±8.48^{a}
	M	78.01±0.65^{ab}	2.63±0.12^{a}	14.60±0.77^{a}	1.63±0.08^{ab}	3.13±0.32^{a}	82.06±2.90^{a}
	Mean	78.61±1.38	1.82±0.98	16.17±1.79	1.74±0.34	1.85±1.51	88.45±8.81
Winter	F	74.62±0.68^{bc}	3.10±0.09^{b}	14.48±0.23^{b}	1.92±0.08^{ab}	5.89±0.92^{b}	109.77±1.99^{bc}
	M	74.68±0.04^{bc}	2.38±0.05^{a}	15.04±0.17^{a}	2.37±0.29^{ab}	5.54±0.24^{b}	82.18±1.46^{a}
	Mean	74.66±0.40	2.69±0.39	14.80±0.35	2.17±0.32	5.69±0.59	106.12±3.37
Spring	F	77.61±0.30^{ac}	1.06±0.19^{a}	17.07±0.07^{ab}	1.59±0.04^{a}	2.67±0.51^{ac}	90.34±0.19^{a}
	M	79.97±2.36^{a}	1.45±0.20^{b}	16.41±1.54^{ab}	1.23±0.36^{a}	0.93±0.81^{c}	102.28±8.23^{b}
	Mean	79.07±2.15	1.28±0.24	16.66±1.21	1.37±0.33	1.62±1.09	84.64±6.99
Summer	F	72.20±0.04^{b}	0.45±0.44^{a}	19.12±1.62^{a}	2.87±0.11^{b}	5.36±1.46^{bc}	102.70±2.58^{b}
	M	73.87±1.64^{b}	0.92±0.19^{c}	17.67±0.72^{b}	2.41±0.59^{b}	5.14±0.95^{b}	89.60±4.28^{a}
	Mean	73.31±1.54	0.76±0.35	18.15±1.23	2.57±0.52	5.21±1.06	100.30±3.83
F×M	t	–0.465	–1.012	1.398	0.491	–0.147	0.169
F×M	P	0,645	0.320	0.173	0.627	0.884	0.867

Values are shown as mean±standard deviation of replicate measurements for two independent and parallel experiments. F×M means the changing on the proximate contents of all shrimps (without the difference on sex) according to season. Different superscript letters in the same column indicate significant differences between seasons on female or male independently ($P<0.05$)

Table 2. The chemical, microbial, and sensoric changes of *P. kerathurus* stored at room temperature (RT) and during ice storage (IS)

Day	pH		TMA-N (mg/100 g)		TMC (log CFU g^{-1})		Sensory			
							Odour		Appearance	
	RT	IS	RT	IS	RT	IS	RT	IS	RT	IS
0	7.25±0.36^{a}	7.25±0.36^{a}	0.42±0.46^{a}	0.42±0.46^{a}	4.34±0.05^{a}	4.34±0.05^{a}	5.0±0.0^{a}	5.0±0.0^{a}	5.0±0.0^{a}	5.0±0.0^{a}
1	7.45±0.54^{a}	7.28±0.37^{a}	2.59±0.80^{a}	0.08±0.07^{a}	5.45±0.03^{b}	4.28±0.20^{a}	2.0±0.0^{b}	5.0±0.0^{a}	2.5±0.5^{b}	5.0±0.0^{a}
2	7.76±0.42^{a}	7.31±0.28^{a}	10.00±0.00^{b}	0.30±0.34^{a}	7.29±0.05^{c}	4.40±0.14^{a}	1.0±0.0^{c}	5.0±0.0^{a}	1.0±0.0^{b}	5.0±0.0^{a}
3	–	7.32±0.16^{a}	–	0.19±0.02^{a}		4.59±0.02^{ab}		4.0±0.0^{ab}		4.5±0.5^{a}
4	–	7.32±0.04^{a}	–	0.78±1.01^{a}		4.73±0.01^{bc}		4.0±0.0^{ac}		4.0±0.0^{ab}
5	–	7.27±0.16^{a}	–	0.08±0.06^{a}		4.77±0.01^{bcd}		3.0±0.0^{bcd}		3.0±0.0^{bc}
6	–	7.43±0.01^{a}	–	0.14±0.02^{a}		4.79±0.01^{bcd}		2.5±0.5^{de}		3.0±0.0^{bc}
7	–	7.57±0.23^{a}	–	1.92±0.16^{a}		4.87±0.00^{bcd}		2.5±0.5^{de}		3.0±0.0^{bc}
8	–	7.65±0.06^{a}	–	2.16±2.02^{a}		4.94±0.01^{cd}		2.0±0.0^{def}		2.5±0.5^{cd}
9	–	7.94±0.04^{a}	–	6.99±0.03^{b}		4.97±0.01^{cd}		1.5±0.0^{ef}		1.5±0.5^{de}
10	–	8.02±0.04^{a}	–	10.00±0.00^{c}		5.09±0.07^{d}		1.0±0.0^{f}		1.0±0.0^{e}

Values are shown as mean±standard deviation of replicate measurements for two independent and parallel experiments for pH, TMA-N and TMC, for ten panelists for sensorial analysis. Different superscript letters in the same column indicate significant differences between groups ($P<0.05$)

The values of pH did not change significantly during storage ($P>0.05$). Minimal and maximal values were of 7.25 and 7.76 (Table 2), respectively, and were obtained on days 0 and 2 for the samples at room temperature. However, the values of samples at ice storage were 7.25 and 8.02 on days 0 and 10, respectively (Table 2). Similar values were reported by Varlik and co-workers (1993); Martinez and co-workers (2001); Lopez-Caballero and co-workers (2007). Varlik and co-workers (2000) obtained low pH values during chilled storage of shrimp (6.73).

TMA-N values changed during storage, displaying a statistically different ($P<0.05$) increasing trend. The inital average value was 0.42±0.46 mg of TMA-N per 100 g of muscle (Table 2). Similar values were detected by other authors (Varlik et al., 1993; Huidobro & Lopez-Caballero, 2002; Gökoğlu, 2004; Lopez-Caballero et al., 2007). However, lower TMA-N contents (1.75 mg of TMA-N per 100 g of muscle) were found in different shrimp species in another study (Martinez et al., 2001). TMA-N exceeded the legal limit of 8 mg per 100 g muscle (Varlik et al., 1993) for the sample at room temperature on day 2. pH values and mesophilic aerobic bacteria counts were positively, and sensory values were negatively correlated to the design variable TMA-N ($P<0.05$). The values of samples at ice storage exceeded the limit on day 10. The values of pH, TMA-N, and mesophilic aerobic bacteria counts were positively, and sensory values were negatively correlated to the design variable TMA-N ($P<0.01$).

The initial mesophilic aerobic bacteria count of prawn was 4.34 log CFU g^{-1} (Table 2). Similar values were observed by Ho and co-workers (1986). Higher values were found in other studies (Diler & Ataş, 2003; Lakshmanan et al., 2002; Niamnuy et al., 2007). The reason of that might be that better hygienic conditions were provided immediately after capturing of prawn in the present study. Generally, the number of bacteria in freshly caught species may usually range from 10^3 to 10^4 CFU cm^{-2} or per gram of the fish tissue (Kanduri & Eckhardt, 2002). The mesophilic aerobic bacteria count exceeded the legal limit of 5 log CFU g^{-1} (Kanduri & Eckhardt, 2002) at room temperature on day 1. However, the samples at ice storage exceeded the limit only on day 10.

The results of sensorial analysis for prawn samples are presented in Table 2. The values significantly changed during storage ($P<0.05$). At first, the score of panelists was 5 (like extremely) on day 0 about odour and appearance of prawn. But later, the value was reduced to 1 (dislike extremely) on the last day of storage (Table 2).

The shelf life of prawn was determined as 1 day at room temperature. Similar values were reported by other authors (Varlik et al., 2000; Gökoğlu, 2004). However, it was longer than that found (6 h) in another study at room temperature (Laghmari & El Marrakchi, 2005) and shorter than was reported by Leitao and Rios (2000) (4 days). At ice storage, it was determined as 9 days. It was longer than those found in other studies (Hanpongkittikun et al.,1995; Leitao & Rios, 2000; Varlik et al., 2000; Gökoğlu, 2004; Laghmari & El Marrakchi, 2005) and fall within those reported by Varlik (1993) and Leitao and Rios (2000) for several shrimp species.

3. Conclusions

In conclusion, from the sensory, biochemical, and microbial point view, chilling of caramote prawn, caught from Gulf of Antalya in Mediterranean Sea along the months of May and June, in water with ice improves quality. Results of this study indicate that shelf lives of caramote

prawn were 1 day and 9 days at room temperature and at ice storage, respectively. The determined shelf-life of chilled caramote prawn, like on the retail seafood markets, seems to be advantageous on account of acceptability for human consumption.

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