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Impact of storage on the chemical composition of wet salted *Mugil cephalus*, *Chonas chonas* and *Gerres oyena* (Pisces) from Port Sudan. Red Sea coast

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Abstract
The impact of storage on the chemical composition of wet salted *Mugil cephalus*, *Chonas chonas* and *Gerres oyena* from Port Sudan. Red Sea coast was studied. Regression analysis showed significant correlation (p<0.05 to p<0.001) between decrease in moisture and in protein content in *M. cephalus*, *C. chonas* and *G. oyena* with storage duration in all salt concentration during both seasons. The fat content showed no consistent pattern in the three species while ash showed no significant correlation (p>0.05) between time of storage and salt concentration.

Keywords: Storage, chemical composition, wet-salted, marine, fish

Introduction
Srikar *et al*. [1] concluded that storage at 2.5±1 °C considerably extends the shelf life of salted *Rastrelliger kangurta* and *Nemipterus japonicas*. Post-harvest treatment was found to prolong the shelf life of fishes (FAO; Abu Gideiri *et al*.; Leroi and Joffraud; Clement and Saheed) [2, 3, 4, 5] at ambient temperature. The methods used included chilling and freezing which decreases the temperature of fish and drying which increases the temperature of fish (FAO [2]. Fish curing comprises drying, smoking, wet-salting and pickling (Borgstrom; Horner) [6, 7]. Curing is usually applied to fish of low consumer preference and/or technically unsuitable for caning (Borgstrom) [6]. Salting by table salt is recognized as fair antimicrobial treatment (Wempe and Davidson; Leroi *et al*.; Reza *et al*.) [8, 9, 10]. Table salt is rich in food additives. According to Burt [11] the best fish to smoke are those with light fat such as salmon, trout, herring and mackerel because they absorb smoke faster and have acceptable texture by the consumer. Prolonged smoking may lead to dry and partially cooked product Borgstrom; Burt [6, 11]. It is of importance during fermentation to avoid using fat fish which are liable to oxidation and rancidity Encyclopedia of Food Sciences and Nutrition; Waindu and Jamala [12, 13]. The objective of this work is to study the impact of storage on the gross chemical composition of wet-salted marine coastal water.

Material and Methods
Fish sampling and preservation
Highly fresh *M. cephalus*, *C. chanos* and *G. oyena* were purchases from Port Sudan fish market. After thoroughly cleaning each species was kept in three coded well tight plastic buckets and received 15%, 20% and 25% table salt by weight and stored till it became mature product at day 21 based on the producer's practices.

Proximate chemical analysis
The proximate composition (moisture, protein, fat and ash) were determined using the standard methods of the Association of Official Analytical Chemists (AOAC) [14]. Samples for determination of chemical composition were picked up randomly from each bucket every third day till day 21. Each reading of a chemical constituent is the mean of three replicates for each specimen.

Statistical analysis

Simple regression analysis was used to determine the correlation between the means of chemical composition of the three fish species during summer and winter with storage time. A probability of ($p<0.05$) was considered to be statistically significant.

Results: In *M. cephalus* regression analysis showed significant correlation ($p<0.05$ to $p<0.001$) between decrease in moisture and protein with storage time (Table 1) in all salt concentration during both seasons. The magnitude of change in fat was inconsistent ($p>0.05$ to $p<0.001$). In case of ash the correlation was insignificant ($p>0.05$). Table 1.

Table 1: The relationship between some chemical constituent of *Mugil cephalus* at different salt concertation and seasons with time. (T)

Parameter	Salt Conc.	Summer		Winter	
		Regression equation	p-value	Regression equation	p-value
Moisture (M)	15%	M= 7.895 – 0.042T	p=0.010	M=13.613– 0.043T	p=0.022
	20%	M=10.546 – 0.107T	p=0.045	M=8.774 –0.063T	p=0.001
	25%	M= 8.662T– 0.019T	p=0.001	M=7.8 49 – 0.367T	p=0.047
Protein (P)	15%	P=28.966 – 0.122T	p=0.038	P=30.956 – 0.155T	p=0.010
	20%	P=28.523 – 0.111T	p=0.037	P=30.295 – 0.146T	p=0.033
	25%	P=27.163 – 0.102T	p=0.050	P=29.709 – 0.146T	p=0.040
Fat (F)	15%	F=11.533 – 0.070T	p=0.144	F=10.030 – 0.029T	p=0.072
	20%	F=15.403 – 0.106T	p=0.074	F=10.068 – 0.034T	p=0.028
	25%	F= 7.461 – 0.020T	p=0.031	F= 8.774 – 0.024T	p=0.001
Ash (A)	15%	A=10.818 – 0.470T	p=0.224	A=16.165 – 0.055T	p=0.232
	20%	A=12.063 + 0.025T	p=0. 406	A=16.637 – 0.039T	p=0.076
	25%	A= 6.283 + 0.074T	p=0.059	A=18.046 – 0.061T	p=0.101

In *C. chonas* the trend of the results of regression analysis (Table 2) was typical to that of *M. cephalus.*

Table 2: The relationship between some chemical constituent of *Chonas chonas* at different salt concertation and seasons with time

Constituent	Salt Conc.	Summer		Winter	
		Regression equation	p-value	Regression equation	p-value
Moisture (M)	15%	M= 9.858 – 0.423T	p=0.033	M= 12.858 – 0.401T	p=0.022
	20%	M=13.613 – 0.097T	p=0.001	M=9.577 – 0.109T	p=0.014
	25%	M= 9.827– 0.096T	p=0.017	M= 7.897– 0.633T	p=0.036
Protein (P)	15%	P=26.182 – 0.085T	p=0.047	P=30.906 – 0.148T	p=0.018
	20%	P=26.401 – 0.092T	p=0.037	P=30.542 – 0.148T	p=0.023
	25%	P=25.193 – 0.079T	p=0.038	P=29.773 – 0.142T	p=0.010
Fat (F)	15%	F= 8.980 – 0.041T	p=0.072	F=10.142 – 0.270T	p=0.321
	20%	F= 8.938 – 0.042T	p=0.028	F= 9.583 – 0.024T	p=0.014
	25%	F= 4.990 – 0.004T	p=0.025	F= 8.524 – 0.019T	p=0.071
Ash (A)	15%	A=10.047 – 0.051T	p=0.430	A=15.509 – 0.085T	p=0.257
	20%	A=13.460 – 0.003T	p=0.307	A=16.776 – 0.030T	p=0.204
	25%	A=12.931 – 0.013T	p=0.131	A=18.540 – 0.043T	p=0.105

In *G. oyena* regression analysis showed significant correlation ($p<0.05$ to $p<0.001$) between decrease in moisture and protein with storage time (Table 3) in all salt concentration during summer and winter seasons. In case of fat and ash the correlation was insignificant ($p>0.05$) with respect to different salt concentrations and seasons.

Table 3: The relationship between some chemical constituent of *Gerrus oyena* at different salt concertation and seasons with time

Constituent	Salt Conc.	Summer		Winter	
		Regression equation	p-value	Regression equation	p-value
Moisture (MT)	15%	M=91.61– 0.038T	p=0.072	M=10.646– 0.051T	p=0.041
	20%	M=8.634 –0.011T	*p*<0.031	M=8.224 –0.032T	p=0.017
	25%	M=7.784 – 0.306T	*p*<0.001	M=11.104 – 0.006T	p=0.033
Protein (P)	15%	P=29.551 – 0.131T	*p*<0.013	P=30.518 – 0.172T	p=0.037
	20%	P=28.502 – 0.119T	*p*<0.047	P=29.948 – 0.142T	p=0.001
	25%	P=26.092 – 0.096T	*p*<0.010	P=29.851 – 0.145T	p=0.072
Fat (F)	15%	F= 9.839 – 0.048T	*p*<0.118	F= 10.426 – 0.040T	p=0.228
	20%	F= 8.938 – 0.037T	*p*<0.389	F=10.875 – 0.049T	p=0.202
	25%	F= 7.631 – 0.025T	P=0.086	F= 8.612 – 0.022T	p=0.430
Ash (A)	15%	A=10.589 + 0.048T	P=0.631	A=15.799 – 0.059T	p=0.137
	20%	A=11.919 + 0.023T	P=0.294	A=17.267 – 0.040T	p=0.539
	25%	A= 7.130 + 0.088T	p=0.430	A=17.530 – 0.065T	p=0.243

Discussion

Salting is one of the oldest techniques known by man for the preservation and increasing of shelf life of fish before other processing methods (Rashad; Hafez *et al.*) [15, 16]. The present study showed that in *M. cephalus, C. chonas* and *G. oyena* regression analysis showed significant correlation ($p<0.05$ to $p<0.001$) between decrease in moisture and protein content with storage duration in all salt concentration during both

seasons. The fat content showed no consistent pattern in the thee species while ash no significant correlation (p>0.05) between time of storage and salt concentration. According to Alsaban *et al*. [17] salting and storage for three months decreased the moisture and protein contents of *Oreochromis niloticus*, *Clarias gariepinus* and *Mormyrus kannume*. General appearance, texture and smell of wet salted fish have significant contribution in product acceptability by the consumers. Srikar *et al*. [1] found that the chemical indices of acceptability were considerably lower in the products stored at 2.5±1 °C compared with room temperature 26.8±3·3 °C. Jittinandana *et al.* [18] found that the higher brine concentration caused dehydration of the fish fillets.
In cold-smoked salmon during 5 °C storage, salt and smoke simultaneously affect chemical and sensory quality (Leroi and Joffraud) [4] as well as microbiological quality (Leroi *et al.*,) [9].
Srikar *et al*. [1] found that storage of dry-salted *Rastrelliger kangurta* and *Nemipterus japonicas* at (26.8±3.3 °C) considerably extend the shelf life of salted fish compared with storage at 2.5±1 °C. Farid *et al*. [19] found that sun-drying of salted *Channa striatus* at room temperature (27 °C-30 °C) increased its shelf life. Majid *et al*. [20] found that storing of *Dasyatis* sp., for 1h in brine was the best treatment to yield a firm product.
Freezing storage add to the keeping quality of *Saurida undosquamis* as concluded by Mazrouh [21] and consequently to other species.

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