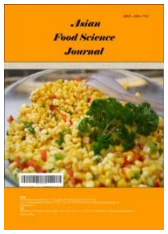

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Quality Evaluation of Different African Catfish *(Clarias gariepinus)* Meat Pickles during Storage

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Fish pickles (made with tomato juice, vinegar, and lemon juice) were made from catfish *(Clariasgariepinus)* and their nutritional quality were evaluated. The quality of the vinegar pickle was excellent, and the quality of the lemon and tomato juice pickle was satisfactory. The moisture content of the pickle products ranged from 67.32 to 67.58% (Treatment 1 = with vinegar), 66.60 to 67.03% (Treatment 2= with tomato juice), and 67.18 to 67.55 % (Treatment 3= with lemon juice) up to 90 day storage at ambient temperature. The protein and lipid contents of pickle with vinegar, tomato juice and lemon juice were ranged from (16.91-16.38 and 13.46-13.78), (18.01-17.68 and 13.46-13.85) and (16.72-16.43 and 13.62-13.97%), respectively; ash content in all sample pickling was ranged from (0.98 to 1.30%). The quality of catfish pickles stored at room temperature was found to be acceptable for consumption after 90 days.

Keywords: Cattfish; pickling; proximate composition; storage.

1. INTRODUCTION

Pickling is an ancient method of food preservation that was practised by the ancient Indians, Egyptians, and Chinese, according to historical evidence. Pickled foods are considered delicacies with a long shelf life. Pickled fish and prawns are currently produced using organic

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acids as pickling agents in conjunction with spices. Pickling preserves the food's wholesomeness and nutritional value for an extended period of time. Pickles have a growing market potential in Asian-majority countries right now **Gopakumar K, [1]** Pickling is one of the most simplest and safe ways to preserve fish and shellfish. Pickles are now commonly served as a side dish by a large number of people. Pickles are a tasty appetizer that, in addition to being highly nutritious, add to the palatability of starch-based Asian dishes with a bland flavor. The technology is easy, simple to use and can be quickly adopted by farmers and fishermen. There is no need for expensive facilities equipment, and the initial investment is minimal **Kumar and Basu [2]** Because of their rigidity, inertness, non-toxicity, durability, compatibility and indigenous availability, glass bottles are commonly used to package pickles. Because of its inertness and impermeability to moisture and gases, glass packaging gives pickles a long shelf life. **Pagarkar et al., [3]** reported that, pickling is a simple and healthy method of preserving fish for short-term storage. It also has commercial significance in a number of Asian and African countries. Due to increased urbanization, social, and cultural shifts, there has been a rise in demand for value-added fishery products in recent years **Sharma and Sarma [4]** To increase profitability, value-added products such as fish pickle made from low-cost fish catfish *(Clarias gariepinus)* could usher in a new era of production and supply for human consumption in Egypt.

In reality, value-added fisheries products will help Egypt's established fish processing industries right away. Due to the abundance of catfish output in Egypt, the market price of catfish often falls. As a result, it could be used as a source of raw material for fish pickles, which could provide people with good taste and nutrition at a lower cost.

2. MATERIALS AND METHODS

2.1 Raw Materials

During June 2020, live catfish were purchased from a local market in Assuit, Egypt. A total of ten fish were captured, each weighing an average of 2,043 g. The fish were transported in ice-box to the Department of Food Science and Technology at Al-Azhar University's Faculty of Agriculture in Assuit, Egypt.

2.2 Methods

2.2.1 Cattfish meat pickle preparation

Cattfish meat pickle was prepared according to **[5]** with some modifications using vinegar ,lemon juice and tomato sauce as shown in the flowchart and Chart (1). The samples were rinsing in salt water and then removed the water from fish. Then the fish samples were marinating with half spices (salt, chili powder and turmeric powder) were mixed together with 300 ml water and held at room temperature for 30 min. After marinating the samples were fried in 300 ml oil on a low heat until golden brown Then fried the onion, garlic, and ginger paste. Cumin powder, cloves, salt, sugar, and vinegar were added as required then the fried bits were combined and heated for 3-4 min until the veg was absorbed. To this is added tamarined water and sodium benzoate. Cooled to room temperature before being sealed in a glass bottle then Storage at ambient temperature for 3 months.

2.2.2 Physicochemical properties

2.2.2.1 The pH value

Homogenizing 10 g of prepared Catfish meat pickle, then the sample with 90 ml distilled water for 30 seconds, the pH values were determined, using a pH-meter (Jenway 3010; Jenway Ltd., Essex, UK) at 20°C, as defined by **Fernandez-Lopez et al. [6]**

2.2.2.2 Determination of Total volatile bases (TVBN)

The total volatile bases was estimated as described by A.O.A.C [7] 10g of sample was added to the heating flask containing 300 ml distill water plus 2 gm magnesium oxide. In the receiving flask 25 ml of boric acid (2%), a few drops of methyl red indicator was added. After 25 minutes, distillation was stopped. The content of the receiving flask was transferred to another flask and titrated with 0.05N (H2SO4).The total volatile nitrogen was determined as follows:

$$TVB = \frac{(V \times N \times 100 \times 14)}{W}$$

Where:
V=volume (ml) H_2SO_4 used for sample.
N=normality of H_2SO_4.

W=weight of sample in grams.

2.2.2.3 Determination of Acidity

The Acidity of prepared Catfish meat pickle was determined according to method of **[8]** as follows: Ten grams of sample +50 ml ethyl ether: ethyl alcohol 2:1(v/v), with continuous stirring for 10 min, neutralization titration with NaOH 0.1 mol/L using phenolphthalein as an indicator, and the values were expressed as (% as oleic acid).

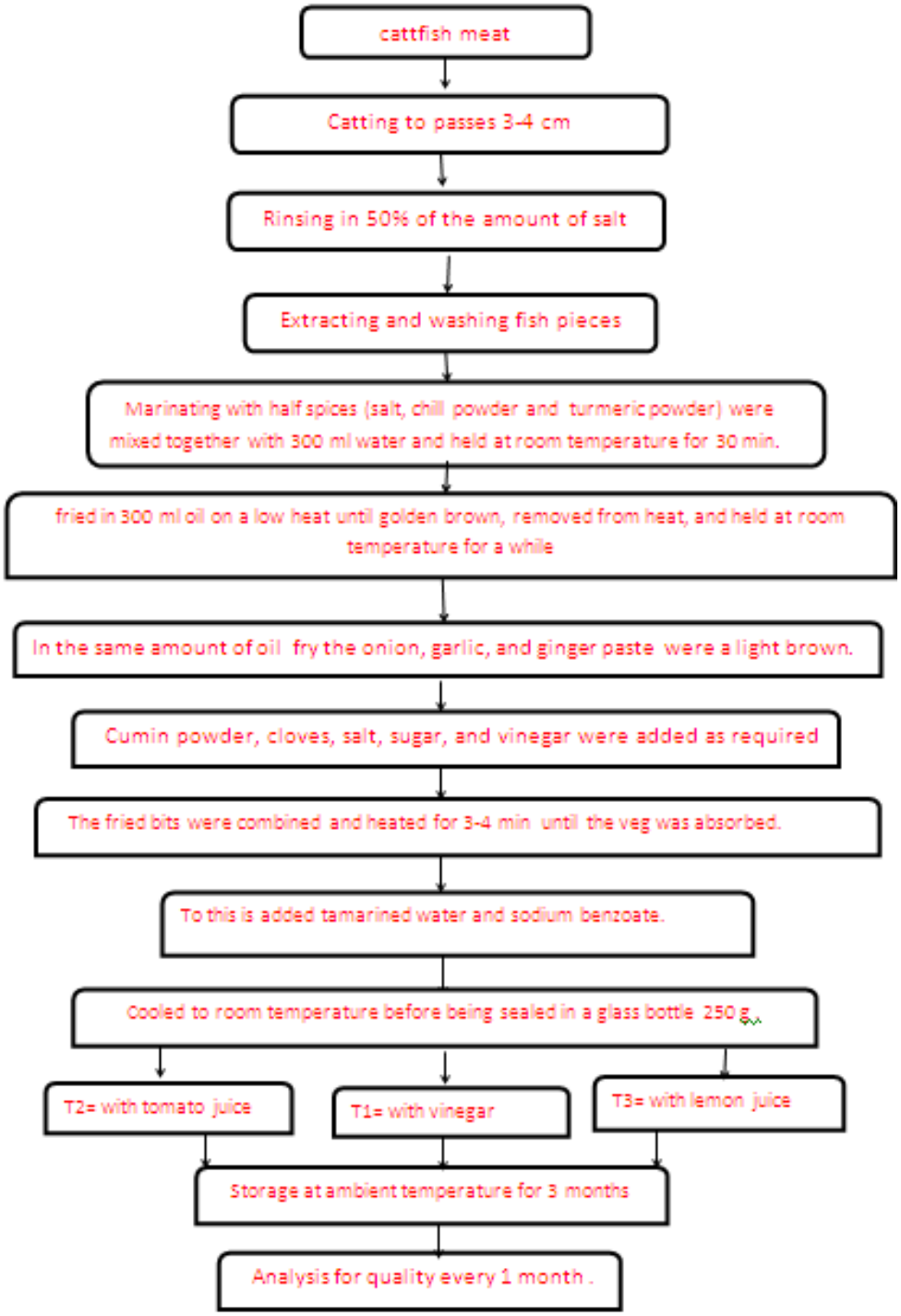

Fig. 1. Flowchart of catfish meat pickle



Plate 1. Marinated cattfish met Plate 2. Fried and mix ingredient Plate 3. Cooking fish pickled



Plate 4. packed and stored

Table 1. Formula of catfish meat pickle

Ingredient	T1=with Vinegar	T2= with Tomato Juice	T3= with Lemon Juice
Fish meat	1000 g	1000 g	1000 g
Chili powder	40 g	40 g	40 g
Turmeric powder	4 g	4 g	4 g
Cumin	20 g	20 g	20 g
Onion	40 g	40 g	40 g
Ginger	2o g	2o g	2o g
Garlic	160g	160g	160g
Oil	300 ml	300 ml	300 ml
Sodium benzoate	2 g	2 g	2 g
Tamarind	40 g	40 g	40 g
Vinegar	100 ml	100 ml	100 ml
Black pepper	4 g	4 g	4 g
Clove	4 g	4 g	4 g
Sugar	100 g	100 g	100 g
Salt	60 g	60 g	60 g
Tomato juice	-----	60 g	-----
Lemon juice	-----	-----	60 ml

2.2.2.4 Determination of Thiobarbituric acid (T B A)

Thiobarbituric acid (TBA) values were determined according to the method of Pearson [9] as follows: Ten grams of sample were distilled using distilled 98 ml water +4ml HCl for 10 min. Five ml of the distillates were mixed with 5 ml of TBA solution (0.2883 gm. TBA / 100 ml. of 90% glacial acetic acid) into a stopped tube, which was then heated in boiling water for 35 min. After cooling, measurement was carried out calorimetrically at 538 nm. The TBA values were calculated by multiplying the absorbance by the factor of 7.8 and the results were represented as mg. of malonaldehyde /kg sample.

2.2.3 Proximate chemical composition

The proximate chemical composition was determined according to the **AOAC method [10]**

The moisture content was determined by drying 5 g of fish sample in an oven at 105°C until a constant weight. Crude protein content was determined by the Kjeldahl method was calculated by multiplying the nitrogen content by 6.25 and the results expressed as % protein. and the crude fat content was determined by the Soxhlet method. The ash content was determined by ashing the samples overnight at 550°C.

2.2.4 Microbial evaluation

- **Sample preparation**

  Ten grams of each sample were mixed with 90ml of sterile peptone solution (9gm peptone/1L distilled water) in a blender, under sterile conditions to give 1/10 dilution. Serial dilutions were prepared to be used for counting several types of bacteria.

- **Total plate bacterial count**

  The total plate bacterial counts were determined using the plate counts technique on a nutrient agar medium according to procedures by **A.P.H.A [11]** and **Difco (1984)**. The plates were incubated at 37^{o}C for 48 hrs.

- **Halophilic count, Yeast and Mould count (YMC)**

  Halophilic count, yeast and mould count (YMC) were determined by the methods described by **ICMSF [12]**

2.2.5 Sensory evaluation

The samples of prepared catfish meat pickle were tested for sensory parameters by ten experienced panelists were chosen from the staff members of the Department of Science Food and Technology, Faculty of Agriculture, AL- Azhar University, Assuit, Egypt. Judging score for each factor was as follows; 9 – 8 very good; 7– 6 good; 4 – 5 fair; 2 – 3 poor and 0 -1 very poor **[13]**

2.3 Statistical Analysis

The obtained data from three replicates were analyzed by (ANOVA) using the SPSS .

statistical package program, and differences among the means were compared using the Duncan's Multiple Range test **SPSS [14]** A significant level of 0.05 was chosen.

3. RESULTS AND DISCUSSION

3.1 Proximate Chemical Composition of the Prepared Catfish Meat Pickle

Proximate chemical composition of cattfish meat pickle acidified by vinegar, lemon juice and tomato juice are presented in Table (1). The moisture content was ranged from 66.60 to 67.32 %. The results was higher with those of **Pervin et al. [15]** who reported that, Moisture content of the two products varied from 43.85 to 50.89% with the higher value recorded for mola *(Amblypharyngodon mala)* pickles produced with olive. However, the moisture content of catfish meat pickle was lower than that of fresh meat (71.30%). The reduction in moisture content of pickled meat may be due to the evaporation of water during cooking. Furthermore, the moisture content in catfish meat pickle with vinegar (67.32%) was relatively higher than that in catfish meat pickle with lemon juice (67.18%) and significantly higher ($p<0.05$) than that in catfish meat pickle with tomato juice (66.60%). The protein content in catfish meat pickle with vinegar and catfish meat pickle with lemon juice recorded 16.91% and 16.72%, respectively. This result were lower with those reported by **Pervin et al. [15]**who reported that, the protein content varied from 13.16 to 19.13% from mola *(Amblypharyngodon mala)* pickles produced with tamarind and pickles with olive, respectively. The protein content in the cattfish meat pickle with tomato juice recorded 18.01±0.12% which was significantly higher than that of the two other types of the prepared pickles and that may be due to the reduction of moisture in these type of cattfish meat pickle compared with the two other types (Table 1).

The fat content was ranged from 13.46 to 13.62 %. The results were lower than that reported by **Pervin et al. [15]** who found the fat content Lipid content varied from 35.64 to 35.27% on wet weight basis from mola *(Amblypharyngodon mala)* pickle with tamarind and mola pickle with olive and that may be due to the differences in primary samples or ingredients. Moreover, the fat content of catfish meat pickle was higher than that of fresh meat (8.10%).The increase in fat content of

pickled meat may be due to reduction of moisture content and addition of oil during pickle processing. Such results are agreement with the result of **kumar and Basu [2]** for prawn pickle.

Data in Table (1) revealed that, there was significantly differences between all types of prepared catfish meat pickle for the ash contents. However, the ash content was ranged from 0.98 to 1.00%. On other hand, **Pervin et al. [15]** found that, the ash content of mola *(Amblypharyngodon mala)* fish pickle was 1.00 %.

3.2 Physiochemical Properties of the Prepared Cattfish Meat Pickle

Data in table (2) showed some physiochemical properties of the prepared catfish meat pickles. The pH value of catfish meat pickle was ranged from 5.67 to 5.95. Moreover, the pH value of the catfish meat pickles prepared with vinegar and lemon juice was lower than that prepared with tomato juice as a result of citric and ascorbic acids

The pH value in prawn pickle was ranged between 4.61to 4.54.As reported by **kumar and Basu [2]** While, **Rahman et al., [5]** discovered that the pH value of Thai Pangus *(Pangasianodon hypophthalmus)* pickle was 6.83±0.040 in zero time and 6.79±0.036 in refrigeration and frozen storage conditions, respectively. The acid value of prepared cattfish meat pickle was ranged between 1.60 to 1.70% as shown in (table 2).However, the high of titrable acidity of catfish meat pickle could be due to addition of vinegar, lemon juice and tomato juice during pickling process. On other hand, the titrable acidity of prawn pickle ranged from 0.36 to 0.75. As reported by **kumar and Basu [2]** The value of TVB-N recorded 4.74±0.31, 4.28±0.09 and 4.61±0.39 mg /100g in cattfish meat pickle prepared with vinegar, lemon juice and tomato juice, respectively. However, **Chellaram [16]** found that, the TVB-N values were 5.3, 5.2 and 5.15 mg/ 100g in the control, acetic acid and lactic acid respectively. The values of TBA recorded 0.60±0.02, 0.65±0.01 and 0.71±0.01 mg malonaldehyede / kg in cattfish meat pickle prepared with vinegar, lemon juice and tomato juice, respectively.Meat products with a TBA value of less than 3 mg malonaldehyde/kg can be deemed in satisfactory oxidative preservation state, according to **Al-Khatani et al. [17].**

3.3 Microbial Evaluation of the Prepared Cattfish Meat Pickle

The mean values of total plate count (TPC), Halophilec count (HC) and Yeast and Mould counts (YMC) per g of cattfish meat pickle are shown in Table (3). The total plate count recorded 3.03 log cfu/g in cattfish meat with lemon juice which was significantly higher ($p<0.05$) than that of the pickle meat with vinegar which recorded 2.59 log cfu/g and the cattfish pickle meat with tomato juice which recorded 2.65 log cfu/g. Such results are agreement with the result of **Shikha et al., [18]** she reported that, the bacterial load in fish pickle was 2.5×10^3 cfu /g at the start. On the other hand, **Chellaram [16]** indicated that, the total plate count in the control pickle decreased marginally during the first month, but steadily increased over the following months, reaching 97×10^3 to 57×10^4 cfu/g after 6 months of storage. **Mukundan and Radhakrishnan [19]** reported that pickles have very low bacteria counts due to the inhibitory action of the pickles low pH and high salt content. However, the obtained result in this study was in the same line with the result of **Chandrasekar [20]** who found that the total plate count of $10^3$to 10^5 CFU g^{-1} in fish pickle.

Table 2. Proximate chemical composition of the prepared cattfish meat pickles(on wet weight bases)

Parameters	Cattfish meat		
	With Vinegar	With Lemon Juice	With Tomato Juice
Moisture (%)	67.32±0.05^a	67.18±0.08^b	66.60±0.13^c
Protein (%)	16.91±0.03^b	16.72±0.18^c	18.01±0.12^a
Fat (%)	13.46±0.03^b	13.62±0.11^a	13.46±0.06^b
Ash (%)	1.00±0.01^a	0.99±0.02^b	0.98±0.01^c

Different superscript letters indicates significance with in the same row (p<0.05)

Table 3. Physiochemical properties of the prepared cattfish meat pickle

Parameters	Cattfish Meat		
	With Vinegar	With Lemon Juice	With Tomato Juice
pH	5.67±0.01[b]	5.94±0.03[a]	5.95±0.05[a]
Acid value (%)	1.66±0.08[a]	1.70±0.12[a]	1.60±0.14[a]
TVN mg/100g	4.47±0.31[b]	4.28±0.09[c]	4.61±0.39[a]
TBA (Mg malonaldehyede/kg)	0.60±0.02[c]	0.65±0.01[b]	0.71±0.01[a]

Different superscript letters indicates significance with in the same row (p<0.05)

Table 4. Microbial evaluation of the prepared cattfish meat pickle

Parameters (log cfu/g)	Cattfish Meat		
	With Vinegar	With Lemon Juice	With Tomato Juice
TPC	2.59±0.22[b]	3.03±0.14[a]	2.65±0.25[b]
HC	2.40±0.05[a]	2.10±0.10[b]	2.30±0.05[b]
YMC	ND	ND	ND

Different superscript letters indicates significance within the same row (p<0.05)
TPC= Total plate count, HC= Halophilic count, YMC= Yeast and mould count, ND= not detected

The halophile count (HC) in cattfish meat pickle was ranged from 2.10 to 2.40 log cfu/g. Besides, the halophile count (HC) in cattfish meat pickle with lemon juice and tomato juice was significantly lower than that prepared with vinegar as shown in Table (3) and that may be due to the lower of pH value (Table 2). The yeast and mould counts (YMC) was not detected in all prepared cattfish meat pickles as shown in Table (3).

3.4 Sensory Evaluation of the Prepared Catfish Meat Pickle

Data in Table (4) reveled that, the average sensory evaluation results of prepared cattfish meat pickles. The color and flavor of all types of prepared cattfish meat pickles were rated 8-9 by the panelists, indicating that they were very good. Whereas texture, saltiness, and sourness properties scored 7-8, indicating favorable acceptance, with the exception of the sourness of cattfish meat pickle with vinegar, which scored 6. However, the overall acceptability in all types of prepared quail meat pickles was 8-9, indicating very good acceptances for the panelists. Furthermore, there were no differences in overall acceptability between the cattfish meat pickles prepared with vinegar and tomato juice, which were more acceptable than the cattfish meat pickle prepared with lemon juice. These observations are similar to those observed by **Pervin et al. [15]** in fish pickles from mola *(Amblypharyngodon mala*

3.5 Effect of Storage at Ambient Temperature for 3 Months on Proximate Chemical Composition of the Prepared Cattfish Meat Pickle

Effect of storage at ambient temperature for 3 months on proximate chemical composition of the prepared cattfish meat pickles are presented in Table (5). The data indicated that, there were sleight increment in moisture content in the cattfish meat pickle during the storage period. The same observation was reported by **Baygar et al. [21]** the moisture content of marinated sea bass fillets pickled increased until maturation time then decreased between 6 and 36 h, and then increased again at the end of storage time. While, **Shikha et al., [18]** reported that, fresh fish had an initial moisture content of 78.87 %. Moisture content of fish pickle was 57.25 % on "0"day for mustard oil pickle, which gradually decreased after 7 days of storage to 42.06 % and 36.92 % after 15 days of storage. The increase in moisture content may be due to some moisture picked up from the moist medium. Regarding to the protein content, there were sleight decreases during the storage period up to 30 days. The decrement in protein content became significant at 60 and 90 days as shown in Table (5). On other hand, **Shikha et al., [18]** reported that, the protein content was 19.47, 17.67and 15.99 for Fish Pickle (Dorsal and Whole Fish Muscle) at 0, 7 and 15 storage days, respectively. The fat content of cattfish meat pickles increased up to 60 days of storage and

that may be due to the decrease of moisture content. Then the fat content decreased again at 90 days of storage and that may be due to some hydrolysis of the fat. Likewise, the fat content as reported by **Rahman et al., [5]** found that, in a refrigerated pickle, lipid content increased during the study period, but it decreased after five months of storage.

Data in Table (6) reveled that, there was a significant increase in ash content of the prepared cattfish pickles during the storage period. The increase in ash content may be due to the processed fish pickle loses moisture during frying and cooking. The same observation was reported by **Rahman et al. [5]** the ash content of fish pickle increased as the storage time increased in both refrigeration and frozen storage conditions. Also, **Pawar and Sonawane [22]** reported that, this ash's appearance is due to a decrease in moisture content during storage.

3.6 Effect of Storage at Ambient Temperature for 3 Months on Physiochemical Properties of the Prepared Cattfish Meat Pickle

Effect of storage at ambient temperature for 3 months on physiochemical properties of the prepared catfish meat pickles are presented in Table (6). Data revealed that, there was a significant decrease in the pH value with increasing of the storage period. The increase in titratable acidity, vinegar, lemon juice, and tomato juice during processing, as well as its gradual absorption by fish pickle, could explain the decrease in pH value. The result was in agreement with the result of **Rahman et al., [5]** who indicated that, the pH value of fish pickle stored under refrigeration and frozen storage decreased significantly as the storage period lengthened. Also, **Tamilselvi et al., [23]** and **Dhanapal et al., [24]** found a similar decreasing trend in pH during pickle storage. On the other side, Kumar and Basu [2] indicated that, after 210 days of storage, the pH of the prawn pickle gradually decreased from 4.64 to 4.51.

Regarding to the acid value, data in table (6) indicated that, there was a significant increases during the storage period in all prepared catfish meat pickles as a result of some hydrolyses of the fat or through fermentation. However, **Kumar and Basu [2]** reported that, during the 210 days of storage, the titrable acidity rose from 0.36 to 0.75. During 120 days of prawn pickle storage, **Abraham and Jayachandran [25]** observed a similar drop in pH and rise in titrable acidity. During three months of storage there was a significant ($p<0.05$) increase of TBA value from 0.60 to 1.31 mg malonaldehyde/ kg in all prepared catfish meat pickles. From 0 to 90 days of storage, TBA values increased **Reddy and Rao [26]** and **Nayak et al., [27]**found similar tendencies in pickled. The TVB-N value ranged from 4.28±0.09 to 4.61±0.39 mg/100g of cattfish meat pickles at zero time which increased to range from 11.33±0.08 to 11.62±0.20 mg/100g at the end of storage period (90 days) as indicated in table (6). In the same line **Chellaram [16]** reported that, over the 6 months of storage, the TVB-N values increased steadily. After 6 months of storage, the value in the control samples increased from 5.3 to 55.64. After 7 months of storage, the change in TVB-N value increased from 9.15 to 23.75 mg percent. Also, increased TVB-N values during storage period were recorded by **Kumar and Basu, [2]**

3.7 Effect of Storage at Ambient Temperature for 3 Months on Microbial Evaluation of Cattfish Meat Pickle

The total bacterial count of any food product is inextricably linked to the sanitary conditions of collection, handling, and storage. Microbial activity causes taste, color, and toxin accumulation in meat, according to **Gadekar et al., [28]** Data in Table (7) shows the mean total plate count (TPC), Halophilec count (HC), and Yeast and Mould counts (YMC) of catfish meat pickle. Except for halophilec count (HC), the obtained data suggested that there was a growing trend in microbial number with increasing storage time. In general, total plate count of the cattfish meat pickle ranged from 2.59 to 3.81 log cfu/g during the storage period. However, **Chellaram [16]** reported that, the total plate count values were discovered to have increased during storage and were in the range of 97×10^3 to 57×10^4 CFU/g. In the same line in prawn pickle, **Abraham and Jayachandran [25]** reported a Total Viable Count of 10^3 to 10^5 g-1 and 10^3 to 10^5 g-1, respectively. While, **Kumar and Basu, [2]** indicated that, the total bacterial count gradually increased over the storage period, reaching 2.7×10^4 cfu lg after 7 months. Regarding to the halophilic counts log cfu/g,

there was a substantial increase (P< 0.05) in all treatments up to 60 days of storage, but a drop in its numbers at the end of the storage period (90 days) to be found with no significant (P<0.05) with the products at zero time. For halophilic bacteria to grow, a specific minimum concentration of dissolved sodium chloride is needed. Depending on the microbial species, the salt concentration needed for growth ranges from 2 to 30% **Frazier, [29]** Data in table (7) revealed that, yeast and mould counts (YMC) which was not detected at zero time had a significant increase during the storage period. However, the yeast and mould counts (YMC) was ranged from 1.25 to 1.79 log cfu/g in all studied cattfish meat pickle treatments. The ability of yeast and mould to multiply in acidic environments can explain their presence in these pickle samples. They can also thrive in a wide variety of salt concentrations and moisture content in food materials. Also **Karyantina et al., [30]** observed that mold growth in fermented catfish increases as salt concentrations rise from 10^2 to 10^5 CFU/g.

Table 5. Sensory evaluation of the prepared cattfish meat pickle

Parameters	Cattfish Meat		
	With Vinegar	With Lemon Juice	With Tomato Juice
Color	9±0.01^a	8±0.02^b	8±0.01^b
Flavor	8±0.03^b	9±0.03^a	8±0.01^b
Texture	8±0.01^a	7±0.04^b	7±0.03^b
Saltiness	7±0.01^a	7±0.04^a	7±0.02^a
Sourness	6±0.02^b	7±0.01^a	7±0.03^a
Overall Acceptability	9±0.02^a	8±0.02^b	9±0.02^a

Different superscript letters indicates significance within the same row (p<0.05)

Table 6. Effect of storage at ambient temperature for 3 months on proximate chemical composition of cattfish meat pickle

Parameters		Storage period at room temperature			
		Zero time	30 day	60 day	90 day
T1with Vinegar	**Moisture**	67.32±0.50^c	67.40±0.02b^c	67.47±0.01^b	67.58±0.01^a
	Protein	16.91±0.08^a	16.83±0.01^a	16.50±0.02^b	16.38 ±0.01^c
	Fat	13.46±0.03^c	13.86±0.05^{ab}	13.92±0.01^a	13.78±0.01^b
	Ash	1.00±0.01^b	1.09±0.05^{ab}	1.14±0.07^{ab}	1.30±0.11^a
T2with Lemon Juice	**Moisture**	67.18±0.08^b	67.28±0.17^b	67.38±0.16^a	67.55±0.13^a
	Protein	16.72±0.18^a	16.75±0.02^a	16.53±0.01^b	16.43±0.01^b
	Fat	13.62±0.11^b	14.07±0.06^a	14.13±0.03^a	13.97±0.01^{ab}
	Ash	0.99±0.02^b	1.41±0.27^a	1.57±0.27^a	1.31±0.07^a
T3with Tomato Juice	**Moisture**	66.60±0.13^b	66.72±0.14a^b	66.78±0.12^{ab}	67.03±0.03^a
	Protein	18.01±0.12^a	17.96±0.11^b	17.83±0.08^b	17.68±0.08^b
	Fat	13.46±0.06^c	13.78±0.03^b	13.95 ±0.02^a	13.85±0.05^{ab}
	Ash	0.98±0.01^d	1.46±0.03^b	1.70±0.05^a	1.28±0.06^c

Different superscript letters indicates significance within the same row (p<0.05)
T1, T2 and T3= cattfish meat

4.8 Effect of Storage at Ambient Temperature for 3 Months on Sensory Evaluation of Cattfish Meat Pickle

The effect of storage at ambient temperature for 3 months on sensory evaluation of catfish meat pickle are presented in table (8). The sensory evaluation of catfish meat pickle revealed that catfish meat pickle prepared with vinegar and tomato juice had very good overall acceptability up to 30 days of storage at ambient temperature, and catfish meat pickle prepared with lemon juice had good overall acceptability. However, Significant reductions in organoleptic scores of catfish meat pickle were observed, with scores ranging from good to very good during the storage period, and the product was highly acceptable for up to two months. Furthermore, also after 90 days of storage, the organoleptic evaluation of catfish meat pickle at

room temperature was satisfactory . Such result are in agreement with the results of **Pervin et al. [15]** in fish pickles from mola (Amblypharyngodon mala). Beside **Kumar and Basu, [2]** reported that, up to four months, the overall acceptability level increased gradually. This was due to the product's flavor becoming more developed as it matured. As the time spent in storage increased, the texture became smoother.

Table 7. Effect of storage at ambient temperature for 3 months on physiochemical properties of cattfish meat pickle

Parameters		Storage period at room temperature			
		Zero time	30 day	60 day	90 day
T1with vinegar	pH	5.67±0.01^{a}	5.62±0.02^{a}	5.56±0.01^{b}	5.31±0.01^{b}
	Acid value (%)	1.66±0.08^{c}	2.11±0.06^{b}	2.14±0.07^{b}	2.73±0.13^{a}
	TVN mg/100g	4.47±0.31^{d}	6.36±0.20^{c}	8.91±0.13^{b}	11.53±0.33^{a}
	TBA (Mg malonaldehyede/ kg)	0.60±0.02^{d}	0.70±0.02^{c}	1.06±0.09^{b}	1.23±0.06^{a}
T2with lemon juice	pH	5.94±0.03^{a}	5.91±0.01^{a}	5.75±0.05^{b}	5.35±0.05^{c}
	Acid value (%)	1.66 ±0.12^{c}	2.12±0.06^{b}	2.61±0.12^{ab}	2.86±0.07^{a}
	TVN mg/100g	4.28±0.09^{d}	6.58±0.14^{c}	8.90±0.18^{b}	11.33±0.08^{a}
	TBA (Mg malonaldehyede/kg)	0.65±0.01^{d}	0.74±0.02^{c}	1.15±0.07^{b}	1.26±0.06^{a}
T3with tomato juice	pH	5.95±0.05^{a}	5.87±0.03^{ab}	5.80±0.05^{b}	5.56±0.04^{c}
	Acid value (%)	1.66±0.14^{d}	2.11±0.01^{c}	2.48±0.03^{b}	2.65±0.05^{a}
	TVN mg/100g	4.61±0.39^{d}	6.65±0.15^{c}	8.95±0.16^{b}	11.62±0.20^{a}
	TBA (Mg malonaldehyede/kg)	0.71±0.01^{d}	0.77±0.01^{c}	1.13±0.09^{b}	1.31±0.03^{a}

Different superscript letters indicates significance within the same row ($p<0.05$)
T1, T2, T3= cattfish meat

Table 8. Effect of storage at ambient temperature for 3 months on microbial evaluation of cattfish meat pickle

Parameters		Storage period at room temperature			
		Zero time	30 day	60 day	90 day
T1with Vinegar	TPC	2.59±0.13^{b}	3.71±0.04^{a}	3.64±0.03^{a}	3.81±0.03^{a}
	HC	2.40±0.04^{b}	2.94±0.03^{a}	3.01±0.04^{a}	2.75±0.03^{b}
	YMC	ND	1.25±0.02^{b}	1.55±0.05^{a}	1.73±0.06^{a}
T2with Lemon Juice	TPC	3.03±0.08^{b}	3.45±0.13^{a}	3.36±0.12^{b}	3.60±0.07^{a}
	HC	2.10±0.04^{b}	2.74±0.02^{b}	2.74±0.08^{a}	2.70±0.10^{a}
	YMC	ND	1.39±0.04^{b}	1.51±0.03^{a}	1.58±0.08^{a}
T3 with Tomato Juice	TPC	2.65±0.25^{a}	3.18±0.28^{b}	3.29±0.13^{b}	3.40±0.10^{a}
	HC	2.30±0.05^{a}	2.58±0.12^{b}	3.05±0.10^{a}	2.88±0.10^{b}
	YMC	ND	1.47±0.01^{b}	1.53±0.07^{a}	1.79±0.02^{a}

Different superscript letters indicates significance within the same row ($p<0.05$); TPC= Totalplate count, HC= Halophilic count, YMC= Yeast and mould count, ND= not detected

Table 9. Effect of storage at ambient temperature for 3 months on sensory evaluation of cattfish meat pickle

		Storage period at room temperature			
Parameters		0 day	30 day	60 day	90 day
T1 with Vinegar	Color	9±0.1 ^{a}	8±0.02^{ab}	7±0.02^{b}	6±0.02^{c}
	Flavor	9±0.03^{a}	8±0.02^{ab}	7±0.04^{b}	6±0.02^{c}
	Texture	8±0.01^{a}	8±0.04^{a}	5±0.03^{b}	5±0.04^{b}
	Saltiness	7±0.01^{a}	7±0.03^{a}	5±0.01^{b}	5±0.01^{c}
	Sourness	6±0.02^{b}	7±0.01^{a}	6±0.02^{b}	6±0.03^{a}

	Overall acceptability	9±0.02^{a}	8±0.01^{ab}	7±0.04^{b}	6±0.02^{c}
T2with Lemon Juice	**Color**	8±0.02^{a}	8±0.02^{b}	7±0.01^{b}	5±0.03^{c}
	Flavor	9±0.03^{a}	8±0.03^{b}	7±0.01^{c}	6±0.02^{d}
	Texture	7±0.04^{a}	7±0.02^{a}	6±0.04^{b}	5±0.04^{c}
	Saltiness	7±0.04^{a}	7±0.03^{a}	6±0.03^{b}	7±0.05^{a}
	Sourness	7±0.01^{a}	7±0.01^{a}	6±0.02^{a}	6±0.01^{b}
	Overall acceptability	8±0.02^{a}	7±0.03^{b}	7±0.01^{b}	6±0.01^{c}
T3 with Tomato Juice	**Color**	9±0.01^{a}	8±0.04^{b}	7±0.02^{c}	6±0.03^{d}
	Flavor	8±0.01^{a}	8±0.03^{b}	7±0.03^{b}	6±0.01^{c}
	Texture	7±0.03^{a}	7±0.02^{a}	6±0.01^{b}	6±0.01^{b}
	Saltiness	7±0.02^{a}	7±0.01^{a}	7±0.01^{a}	6±0.02^{b}
	Sourness	7±0.03^{a}	7±0.01^{a}	7±0.01^{a}	6±0.04^{b}
	Overall acceptability	9±0.02^{a}	8±0.01^{b}	7±0.02^{c}	7±0.03^{d}

Different superscript letters indicates significance within the same row($p<0.05$).
T1, T2 and T3= cattfish meat

4. CONCLUSIONS

The chemical composition, microbial evaluation and organoleptic evaluation of the prepared catfish meat pickle it could be recommended that, catfish meat can be successfully used in the manufacture of such meat products as an alternative to other meats such as beef and chicken. Moreover, catfish meat pickling methods can be easily practiced under rural conditions with minimum infrastructure and technological facilities, which may help in developing the cottage industries and generate self-employment for youth.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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