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Effect of Carbohydrates Substitution and Storage Temperatures on the Quality and Shelf-Life of Fish Luncheon

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ABSTRACT

The present work evaluated the quality characteristics and shelf-life of cooked common carp and little tuna fish luncheon processed and formulated using starch, wheat, and soybean flours, then stored at 4± 1 and 20± 1ºC. The moisture, protein, lipid, ash and carbohydrates contents of control cooked common carp and little tuna fish were 60.25, 15.23, 11.67, 1.93, 10.92%, and 56.53, 16.09, 8.77, 3.54, 12.93%, respectively. While the physicochemical and microbiological quality of control cooked carp and little tuna fish were recorded as follows: pH values were 6.12, 5.93; TVBN was 12.20, 18.36mg/ 100g; TMA was 2.80, 3.36mg/ 100g; TBA was 0.70, 0.96mg MDA/ kg; TMBC was 2.22, 3.11cfu/ g; TPBC was 1.52, 2.01cfu/ g; TPC was 2.37, 1.87cfu/ g, and YMC was 1.28, 2.7cfu/ g, respectively. On the other hand, moisture, protein, lipid and overall acceptability scores were significantly decreased ($P \leq 0.05$) during chilled and ambient temperature. While ash, carbohydrates, pH, TVB-N, TMA-N, TBA, TMBC, TPBC, TPC and YMC were significantly increased ($P \leq 0.05$) as affected by chilled and ambient temperature, but did not exceed the maximum permissible limits set by national and international specification. Based on sensory analysis, the shelf- life of both types of fish luncheon was determined to be 18 days. The wheat flour treatment exhibited the best results, followed by soybean flour and starch.

INTRODUCTION

Recently, the consumption for ready-to-eat meat products has considerably increased in the Egyptian society due to its abundance and variety. Meat products quality became a global concern, especially with the increasing public health awareness of the adverse effects of low quality meat owing to fraudulent practices (**Fengou *et al*., 2021; Gezgin *et al*., 2022)**. Due to the high consumption and over prices of meat, adulteration of meat products has become a common practice in several countries by using unauthorized species in the manufacture of meat products to increase quantity and reduce production costs **(Migaldi *et al*., 2016)**. Modern fish processing technologies are used to maximize

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production (quantity and quality) of high nutritive value fish products such as fish luncheon from the underutilized fish species **(Talab, 2011)**.

Recently, cereals have been approved as functional foods due to their contents of dietary fibers, such as beta-glucan and arabinoxylan, proteins, energy, minerals, vitamins, and carbohydrates including resistant starch, oligosaccharides and antioxidants, all of which are necessary for human health. They are used in meat and fish products as fat substitutes since they can retain moisture and provide the textural qualities that fats normally provide, adding to that they have a varying effect on the final flavor of the product **(Ötles & Cagindi, 2006)**.

Luncheon is an important industrial meat produc; it is one of the most acceptable food products, widely consumed and used for fast meats. Usually, it consists of finely chopped meat and fat with or without some added cereals, cured with salt and nitrite and heat processed **(Ranken, 1984)**. Few studies were conducted to produce fish luncheon, for example **Talab (2011)** examined the proximate composition, physicochemical and sensory properties of common carp fish luncheon using natural antioxidants during chilled storage. Moreover, **Ali *et al*. (2017)** evaluated the proximate composition, physicochemical characteristics, color, texture and sensory properties of canned tilapia fish luncheon prepared from minced tilapia fish with 20, 25, 30 and 35% of beef fat and stored at room temperature for 6 months. Additionally, **Farag (2023)** studied the proximate composition, physicochemical and sensory properties of red tuna fish luncheon using various amount of chickpea flour and beef fat. In this context, this study aimed to compare the effect of using starch, corn and soybean flours substitution and different storage conditions on the chemical composition, physicochemical, microbiological and sensory quality of cooked common carp and little tuna fish luncheon.

MATERIALS AND METHODS

Materials

Fish samples collection and preparation

Fifty kg of fresh common carp (*Cyprinus carpio*) with 44± 6.11cm total lengths and 4.45± 0.51kg weights were obtained from Manzala aquatic farm belonging to GAFAD, Egypt during December 2019. Moreover, fifty kg of little tuna (*Euthynnus alletteratus*) with 49± 4.01cm total lengths and 6.50± 0.48kg weights were purchased from Alexandria fish market, Egypt, during December, 2019.

Fish samples were immediately transported using an ice box within three hours to the Fish Processing and Technology Laboratory, El-Kanater El-Khairia, Fish Research Station, National Institute of Oceanography and Fisheries. Fish samples were washed well with tap water, beheaded, gutted, filleted after the removal of scales, fins, skin and large bones, then rewashed carefully and drained.

Ingredients

Fat, starch, wheat flour, sodium chloride, onion powder, garlic powder and spices (black pepper, red pepper, cumin, cardamom, cloves, coriander, cubeb and clove) were purchased from local market (Cairo, Egypt). Soybean flour was obtained from Food Technology Research Institute, Agriculture Research Center, Giza, Egypt.

Processing of fish luncheon

Common carp and little tuna fish luncheon was processed according to the method described by **Ghoneim (1978)**, using the recipes presented in Table (1) as follows: Fish fillets were minced, pressed in cheese cloth to remove excess water and used for luncheon preparation. The ingredients were thoroughly mixed, subjected to final grinding (4mm plate) and stuffed in low-density polyethylene casing. Three batches of fish luncheon were prepared i.e., the first trial: formulated to contain 35% (7.3411) starch as control sample (L1); the second trial: formulated with replacing of 50% of the added starch with wheat flour (L2) i.e., contain starch and wheat flour at the ratio of 1:1; the third trial: formulated with replacing 50% of the added starch with soybean flour (L3) i.e., contain starch and soy bean flour at the ratio of 1:1. Each luncheon treatments were cooked in boiled water at 85°C for 35 minutes. After cooking, fish luncheon samples were cooled at an ambient temperature, packed in polyethylene bags then divided into two halves; one half was stored in a refrigerator at 4± 1°C, while the other half was stored at room temperature (20± 1°C) (Fig. 1). Fish luncheon samples were analyzed immediately (at zero time of storage) and periodically every 6 days until spoilage.

Table 1. Common carp and little tuna fish luncheon recipes

Ingredient	Control (starch)	Wheat flour	Soybean flour
Minced fish	62.92	62.92	62.92
Fat	20.97	20.97	20.97
Salt	2.52	2.52	2.52
Sugar	1.2585	1.2585	1.2585
Onions	1.8877	1.8877	1.8877
Garlic	1.8877	1.8877	1.8877
Black pepper	1.3461	1.3461	1.3461
Red pepper	0.3335	0.3335	0.3335
Cardamom	0.0357	0.0357	0.0357
Cumin	0.1049	0.1049	0.1049
Cloves	0.0210	0.0210	0.0210
Coriander	0.1049	0.1049	0.1049
Cubeb	0.0629	0.0629	0.0629
Starch	7.3411	3.67	3.67
Wheat flour	0.00	3.67	0.00
Soy bean flour	0.00	0.00	3.67

(a) Cooked common carp fish luncheon **(b)** Cooked little tuna fish luncheon

Fig. 1. Cooked common carp and little tuna fish luncheon

Analytical methods

Moisture, crude protein, lipid and ash were determined according to the guidelines of **AOAC (2012)**. Carbohydrates were calculated by the difference in the sum of the values of fat, ash, moisture, and protein content. The pH value was measured as described by **Egbert *et al.* (1992)**. Total volatile basic nitrogen (TVB-N) contents were determined according to the guidelines of **AOAC (2012)**, trimethylamine nitrogen (TMA-N) contents were determined as mentioned by **Pearson (1976)**, and thiobarbituric acid (TBA) values were assessed according to **Siu and Draper (1978)**. Total mesophilic bacterial count (TMBC) and total psychrophilic bacterial count (TPBC) were evaluated based on the method described in **APHA (2001)**. The total plate count (TPC) was determined according to **ISO (2003)** by using a nutrient agar medium as described by **Oxoid (2006)**. Yeast and mold counts (YMC) were ascertained in accordance with **ISO (2008)**. Sensory evaluation was assessed according to the procedure of **Teeny and Miyaauchi (1972)**.

Statistical analysis

Data were expressed as the mean values of three replicates, and standard deviations were statistically analyzed by performing the analysis of variance technique (ANOVA) using the statistical analysis system according to **SAS (2008)**. Differences among means were compared using Duncan's multiple range test (1955) at a significant level of 95% ($P \leq 0.05$).

RESULTS AND DISCUSSION

Chemical composition of fish luncheon

Moisture content

Moisture content is one of the important parameters measured in processed meat products due to its technological importance and microbial stability **(Mohamed *et al*., 2023)**. Changes in moisture content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour, and soybean flour, stored at 4± 1 and 20± 1ºC, are provided in Table (2). The results showed that there were significant differences ($P \leq$ 0.05) in moisture content between control fish luncheon compared to wheat and soybean flour. At zero time, the moisture content of control, wheat, and soybean flour in common carp fish luncheon was measured at 60.25, 60.19, and 61.64%, respectively. By the end of the storage period, these values significantly decreased (*P*≤ 0.05) to 49.85, 50.08, and 50.47% for samples stored at 4± 1ºC, and to 47.53, 47.76, and 48.15% for samples stored at 20± 1ºC. On the other hand, moisture content of control, wheat and soybean flour of little tuna fish luncheon at zero time was measured at 56.53, 57.09, 55.77%. By the end of the shortage period, these values significantly decreased *(P*≤ 0.05) to 47.43, 48.38, 47.22% for samples stored at 4± 1ºC and to 47.94, 48.01, 47.72% for sample stored at 20± 1ºC.

Table 2. Changes in moisture contents of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage time (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	60.25^{aB}	60.19^{aB}	61.64^{aA}	60.25^{aB}	60.19^{aB}	61.64^{aA}
6	58.87^{bB}	58.54^{bB}	59.67^{bA}	56.55^{bA}	56.22^{bB}	57.35^{bA}
12	55.43^{cB}	56.85^{cA}	55.26^{cB}	53.11^{cB}	54.53^{cA}	52.94^{cB}
18	53.26^{dB}	54.12^{dA}	53.05^{dB}	50.94^{dB}	51.80^{dA}	50.73^{dB}
24	51.79^{eA}	51.41^{eA}	51.64^{eA}	49.47^{eA}	49.09^{eB}	49.32^{eA}
30	49.85^{fB}	50.08^{fB}	50.47^{fA}	47.53^{fB}	47.76^{fB}	48.15^{fA}
	Cooked little tuna fish luncheon					
0	56.53^{B}	57.09^{aA}	55.77^{aC}	56.53^{aB}	57.09^{aA}	55.77^{aC}
6	53.26^{B}	54.12^{bA}	53.05^{bB}	55.89^{bB}	56.55^{bA}	55.09^{bB}
12	51.79^{cA}	51.41^{cA}	51.64^{cA}	53.08^{cB}	54.12^{cA}	53.63^{cB}
18	49.85^{dA}	50.08^{dA}	50.47^{dA}	47.94^{dB}	48.01^{dA}	47.72^{dB}
24	47.43^{eB}	48.38^{eA}	47.22^{eB}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests (*P*≤ 0.05); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests (*P*≤ 0.05). R: rejected.

The variation in the moisture content of the two types examined fish luncheon samples may be influenced by the variable amount of meat added or attributed to the use of sodium chloride or the addition of water, which was added to facilitate chopping the meat and mixing the ingredients **(Lotfi & Youssef, 1966)**. The Egyptian Standard Specification **(ESS, 2005)** demonstrated that the permissible limit of moisture is 60%, which almost nearly similar to the obtained results. For the shelf- life of fish luncheon, it could be noticed that, common carp fish luncheon had 30 day shelf-life both at 4± 1 and 20± 1ºC, while it reached to 24 days for little tuna fish luncheon stored at 4± 1ºC, and 18 days for samples stored at ambient temperatures. **Talab *et al*. (2022)** found a considerable difference in moisture content of fish fingers according to flour type (starch, rice, groats, bean, and soybean) and attributed the decrement in moisture content during storage to the loss of water by evaporation or due to protein denaturation. Similar results were reported by **Ghoneim (1978)**, **Talab and Dolganova (2010)**, **Talab (2011)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Protein content

Protein, as the primary fish component, has a main role in developing muscles and supplying the consumer with essential amino acids that are not synthesized in the body **(Mohamed *et al*., 2023)**. Changes in protein content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour, and soybean flour, stored at 4± 1 and 20± 1ºC, are presented in Table (3).

Table 3. Changes in protein content (%) of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	15.23^{aB}	15.42^{aB}	16.88^{aA}	15.23^{aB}	15.42^{aB}	16.88^{aA}
6	14.97^{aB}	15.07^{aA}	15.64^{bA}	13.65^{bB}	13.75^{bB}	14.32^{bA}
12	13.22^{bB}	14.77^{bB}	15.09^{bA}	11.90^{cB}	13.45^{bA}	13.77^{cA}
18	12.86^{cB}	12.92^{cB}	13.87^{cA}	10.54^{dB}	10.60^{cB}	11.05^{dA}
24	12.69^{cB}	12.78^{cB}	13.03^{cA}	9.77^{eB}	9.46^{dB}	10.71^{eA}
30	12.06^{dC}	12.54^{cB}	12.96^{cA}	8.74^{fA}	9.02^{dA}	8.97^{fA}
	Cooked little tuna fish luncheon					
0	16.09^{aB}	16.34^{aB}	17.79^{aA}	16.09^{aB}	16.34^{aB}	17.79^{aA}
6	15.55^{bB}	15.20^{bB}	16.25^{bA}	14.62^{bA}	14.98^{bA}	15.02^{bA}
12	14.14^{cB}	14.54^{cB}	15.77^{cA}	11.74^{cB}	12.04^{cA}	12.43^{cA}
18	13.80^{dB}	13.28^{dA}	14.33^{dA}	10.89^{dB}	11.11^{dA}	11.66^{dA}
24	12.01^{eB}	12.77^{eA}	12.84^{eA}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests ($P\leq 0.05$); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests ($P\leq 0.05$). R: rejected.

The results showed that there were significant differences ($P\leq 0.05$) between control fish luncheon compared with wheat and soybean flour. Protein content of control, wheat, and soybean flour of common carp fish luncheon at zero time was 15.23, 15.42, 16.88%, and it significantly decreased ($P\leq 0.05$) at the end of storage period to 12.06, 12.54, 12.96% for samples stored at 4± 1ºC, and to 8.74, 9.02, 8.97% for sample stored at 20± 1ºC. Meanwhile, protein content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 16.09, 16.34, 17.79%, respectively. By the end of the storage period, these values significantly decreased ($P\leq 0.05$) to 12.01, 12.77, 12.84% for samples stored at 4± 1ºC, and to 10.89, 11.11, 11.66% for sample stored at 20± 1ºC. **Ali *et al*. (2017)** elucidated that, during storage time of tilapia fish luncheon formulated with different concentrations of beef fat, higher (*P*≤ 0.05) crude protein and lower (*P*≤ 0.05) crude fat were recorded compared to fish luncheon at zero time. However, **Talab *et al.* (2022)** found a considerable difference in protein content of fish fingers according to flour type (starch, rice, groats, bean, and soybean) and attributed the decrement in protein content during frozen storage to protein hydrolysis by enzymatic proteolysis forming small nitrogenous compounds. Similar results were reported by **Ghoneim (1978)**, **Talab and Dolganova (2010)**, **Talab (2011)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Lipid content

Changes in lipid content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour, and soybean flour, stored at 4± 1 and 20±1ºC, are illustrated in Table (4).

Table 4. Changes in lipids contents of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	11.67^{aA}	11.74^{aA}	10.54^{aB}	11.67^{aA}	11.74^{aA}	10.54^{aB}
6	11.14^{aA}	11.02^{bA}	9.85^{bB}	10.64^{bA}	10.52^{bA}	9.35^{bB}
12	10.82^{bA}	10.91^{bA}	9.44^{bB}	10.32^{bA}	10.41^{bA}	8.94^{cB}
18	10.57^{bA}	10.55^{bA}	9.32^{bA}	10.07^{bA}	10.05^{bA}	8.82^{cB}
24	10.29^{bA}	10.03^{bA}	9.07^{bB}	9.79^{bA}	9.53^{cA}	8.57^{cB}
30	9.88^{bA}	9.98^{bA}	8.99^{bA}	9.38^{bA}	9.48^{cA}	8.49^{cA}
	Cooked little tuna fish luncheon					
0	8.77^{eA}	8.84^{eA}	8.19^{eB}	8.77^{dA}	8.84^{dA}	8.19^{dB}
6	9.53^{dA}	9.44^{dA}	8.51^{dB}	9.93^{cA}	9.88^{cA}	8.91^{cB}
12	10.13^{cA}	9.96^{cA}	9.74^{cB}	11.76^{bA}	11.96^{bA}	9.74^{bB}
18	11.54^{bA}	11.68^{bA}	10.22^{bB}	12.14^{aA}	12.08^{aA}	11.87^{aA}
24	12.25^{aA}	12.12^{aA}	10.98^{aB}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests (*P*≤ 0.05); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests (*P*≤ 0.05). R: rejected.

The results showed that there were significant differences (*P*≤ 0.05) between control fish luncheon compared with wheat and soybean flour. Lipid content of control, wheat and soybean flour of common carp fish luncheon at zero time was 11.67, 11.74, 10.54%, and it significantly decreased (*P*≤ 0.05) at the end of storage period to 9.88, 9.98, 8.99% for samples stored at 4± 1ºC, and to 9.38, 9.48, 8.49% for sample stored at 20± 1ºC. Meanwhile, lipid content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 8.77, 8.84, 8.19%, and it significantly increased (*P*≤ 0.05) at the end of storage period to 12.25, 12.12, 10.98% for samples stored at 4± 1ºC, and 12.14, 12.08, 11.87% for sample stored at 20± 1ºC. **Talab *et al*. (2022**) attributed the decrement in lipid content during frozen storage to lipid hydrolysis and formation of some volatile compounds. Similar results were reported in the studies of **Ghoneim (1978)**, **Talab and Dolganova (2010)**, **Talab (2011)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Ash content

Changes in ash content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 4± 1 and 20± 1ºC, are demonstratedin Table (5).

Table 5. Changes in ash contents of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	1.93^{fA}	2.11^{fA}	1.88^{fA}	1.93^{fA}	2.11^{fA}	1.88^{fA}
6	2.67^{eA}	2.43^{eA}	2.89^{eA}	4.04^{eA}	3.80^{eA}	4.26^{eA}
12	3.07^{dA}	3.25^{dA}	3.38^{dA}	4.44^{dA}	4.62^{dA}	4.75^{dA}
18	4.83^{cB}	5.59^{cA}	4.51^{cB}	6.20^{cB}	6.96^{cA}	5.88^{cC}
24	5.91^{bB}	6.74^{bA}	6.28^{bA}	7.28^{bB}	8.11^{bA}	7.65^{bB}
30	7.16^{aB}	7.81^{aA}	7.48^{aA}	8.53^{aA}	9.18^{aA}	8.85^{aA}
	Cooked little tuna fish luncheon					
0	3.54^{eA}	3.30^{eA}	3.76^{eA}	3.54^{dA}	3.30^{dA}	3.76^{dA}
6	3.94^{dA}	4.12^{dA}	4.25^{dA}	4.70^{cB}	4.46^{cC}	5.38^{cA}
12	4.70^{cB}	5.46^{cA}	5.38^{cA}	5.53^{bB}	5.85^{bA}	6.26^{bA}
18	5.53^{bB}	5.85^{bA}	6.26^{bA}	7.98^{aA}	7.84^{aA}	7.69^{aA}
24	6.86^{aA}	6.15^{aB}	7.08^{aA}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests ($P \leq 0.05$); Means followed by different capital letters in the same raw (effect of treatments) are significantly by Duncan´s multiple tests ($P \leq 0.05$). R: rejected.

The results showed that there were significant differences ($P \leq 0.05$) between control fish luncheon compared to wheat and soybean flour. Ash content of control, wheat and soybean flour of common carp fish luncheon at zero time was 1.93, 2.11, 1.88%, and it significantly increased ($P \leq 0.05$) at the end of storage period to 7.16, 7.81, 7.48% for samples stored at 4± 1ºC and 8.53, 9.18, 8.85% for sample stored at 20± 1ºC. Meanwhile, ash content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 3.54, 3.30, 3.76%, and it significantly increased ($P \leq 0.05$) at the end of storage period to 6.86, 6.15, 7.08% for samples stored at 4± 1ºC, and to 7.98, 7.84, 7.69% for sample stored at 20± 1ºC. Identical findings were reported in the research works of **Ghoneim (1978)**, **Talab and Dolganova (2010)**, **Talab (2011)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Carbohydrate content

Changes in carbohydrate content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour, and soybean flour, stored at 4± 1 and 20± 1ºC, are provided in Table (6).

Table 6. Changes in carbohydrate contents of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	10.92^{fA}	10.54^{fA}	9.06^{fB}	10.92^{fA}	10.54^{fA}	9.06^{eB}
6	13.35^{eA}	12.94^{eA}	11.95^{eB}	16.12^{eA}	15.71^{eA}	14.72^{dB}
12	17.46^{dA}	14.22^{dB}	16.83^{dA}	20.23^{dA}	16.99^{dB}	19.60^{cB}
18	18.48^{cB}	16.82^{cC}	19.25^{cA}	22.25^{cB}	20.59^{cC}	23.52^{bA}
24	19.32^{bB}	19.04^{bB}	19.98^{bA}	23.69^{bA}	23.81^{bA}	23.75^{bA}
30	20.65^{aA}	19.59^{aB}	20.10^{aA}	25.82^{aA}	24.56^{aB}	25.54^{aA}
	Cooked little tuna fish luncheon					
0	12.93^{eA}	13.17^{eA}	12.30^{eB}	12.93^{dA}	13.17^{dA}	12.30^{dB}
6	14.45^{dB}	14.15^{dB}	15.22^{dA}	14.86^{cB}	14.13^{cC}	15.60^{cA}
12	17.77^{cA}	15.92^{cC}	16.06^{cB}	17.89^{bA}	16.03^{bB}	17.94^{bA}
18	18.34^{bA}	17.78^{bB}	17.55^{bA}	21.05^{aA}	20.96^{aB}	21.06^{aA}
24	19.03^{aA}	18.88^{aB}	18.63^{aA}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests ($P \leq 0.05$); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests ($P \leq 0.05$). R: rejected.

The results showed that there were significant differences ($P \leq 0.05$) between control fish luncheon compared to wheat and soybean flour. Carbohydrate content of control, wheat, and soybean flour of common carp fish luncheon at zero time was 10.92, 10.54, 9.06%, and it significantly increased ($P \leq 0.05$) at the end of storage period to 20.65, 19.59, 20.10% for samples stored at 4± 1ºC, and to 25.82, 24.56, 25.54% for sample stored at 20± 1ºC. Meanwhile, carbohydrate content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 12.93, 13.17, 12.30%, and it significantly increased ($P \leq 0.05$) at the end of storage period to 19.03, 18.88, 18.63% for samples stored samples 4± 1ºC, and to 21.05, 20.96, 21.06% for sample stored at 20± 1ºC. Similar outcomes were assessed in the works of **Ghoneim (1978)**, **Talab and Dolganova (2010)**, **Talab (2011)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Physicochemical quality changes of fish luncheon

The pH value

Changes in pH value of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 4± 1 and 20± 1ºC, are provided in Table (7). The results revealed that there were significant differences ($P \leq 0.05$) between control fish luncheon compared with wheat and soybean flour. The pH value of control, wheat and soybean flour of common carp fish luncheon at zero time was 6.12, 6.10, 6.07, and it significantly increased ($P \leq 0.05$) at the end of storage period to 6.54, 6.43, 6.58 for samples stored at 4± 1ºC, and to 6.98, 6.83, 6.77 for sample stored at 20± 1ºC. Meanwhile, pH value of control, wheat and soybean flour of little tuna fish luncheon at zero time was 5.93, 5.90, 5.80, and it significantly increased ($P \leq 0.05$) at the end of storage period to 6.25, 6.20, 6.36 for samples stored at 4± 1ºC, and to 6.90, 6.96, 6.99 for sample stored at 20± 1ºC. **Talab *et al*. (2022)** attributed the increase in pH value during chilled storage due to the glycogen breakdown causing lactic acid formation. Similar results were reported by **Talab (2011)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Table 7. Changes in pH contents of cooked common carp and little tuna fish luncheon stored at 4± 1and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	6.12	6.10	6.07	6.12	6.10	6.07
6	6.15	6.18	6.10	6.25	6.27	6.12
12	6.28	6.23	6.17	6.44	6.35	6.30
18	6.30	6.30	6.24	6.65	6.60	6.53
24	6.43	6.38	6.36	6.76	6.77	6.67
30	6.54	6.43	6.58	6.98	6.83	6.77
	Cooked little tuna fish luncheon					
0	5.93	5.90	5.80	5.93	5.90	5.80
6	5.95	5.96	5.85	5.98	5.95	5.92
12	5.99	5.97	6.07	6.07	6.01	6.50
18	6.10	6.07	6.24	6.90	6.96	6.99
24	6.25	6.20	6.36	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests ($P \leq 0.05$); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests ($P \leq 0.05$). R: rejected.

TVB-N content

Changes in TVB-N content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour, and soybean flour, stored at 4±1ºC and 20±1ºC are given in Table (8). The results revealed that there were significant differences ($P \leq$

0.05) between control fish luncheon compared to wheat and soybean flour. The TVBN value of control, wheat, and soybean flour of common carp fish luncheon at zero time was 12.20, 12.26, 12.65mg/ 100g, ww, and it significantly increased ($P\leq 0.05$) at the end of storage period to 27.54, 27.41, 28.92mg/ 100g, ww for samples stored at 4± 1ºC, and to 28.20, 28.2, 28.65mg/ 100g, ww for sample stored at 20± 1ºC. Meanwhile, TVB-N content of control, wheat, and soybean flour of little tuna fish luncheon at zero time was 18.36, 18.30, 18.77mg/ 100g, ww, and it significantly increased ($P\leq 0.05$) at the end of storage period to 30.68, 30.39, 32.84mg/ 100g, ww, for samples stored at 4± 1ºC, and to 30.37, 29.50, 31.32mg/ 100g, ww, for sample stored at 20± 1ºC. Similar results were reported by **Ghoneim (1978)**, **Talab and Dolganova (2010)**, **Talab (2011)**, **Ali *et al.* (2017)** and **Farag (2023)**.

Table 8. Changes in TVB-N values of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	12.20^{dfA}	12.26^{fA}	12.65^{fA}	12.20^{dfA}	12.26^{fA}	12.65^{fA}
6	14.95^{eA}	14.88^{eA}	15.04^{eA}	16.77^{eB}	15.96^{eC}	17.42^{eA}
12	18.70^{dB}	18.64^{dB}	19.35^{dA}	19.86^{dC}	20.55^{dB}	22.65^{dA}
18	20.62^{cB}	20.78^{cB}	21.67^{cA}	24.65^{cB}	23.76^{cC}	25.84^{cA}
24	24.33^{bB}	24.10^{bB}	26.77^{bA}	26.17^{bB}	25.88^{bC}	26.79^{bA}
30	27.54^{aB}	27.41^{aB}	28.92^{aA}	28.20^{aA}	28.26^{aA}	28.65^{aA}
	Cooked little tuna fish luncheon					
0	18.36^{eA}	18.30^{eA}	18.77^{eA}	18.36^{dA}	18.30^{dA}	18.77^{dA}
6	20.41^{dB}	20.33^{dC}	22.94^{dA}	23.41^{cB}	22.36^{cC}	23.94^{cA}
12	22.45^{cB}	22.66^{cB}	25.87^{cA}	26.45^{bB}	25.66^{bC}	27.87^{bA}
18	28.37^{bB}	28.22^{bB}	29.41^{bA}	30.37^{aB}	29.50^{aC}	31.32^{aA}
24	30.68^{aB}	30.39^{aB}	32.84^{aA}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests ($P\leq 0.05$); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests ($P\leq 0.05$). R: rejected.

TMA-N content

TMA-N is produced by the decomposition of trimethylamine oxide (TMA-O) due to bacterial action and possibly through the action of intrinsic enzymes, and it has been suggested as a potential indicator of fish spoilage **(Connell, 1990)**. Changes in TMA-N content of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 4± 1 and 20± 1ºC, are provided in Table (9). The results revealed that there were significant differences ($P\leq 0.05$) between control fish luncheon compared with wheat and soybean flour. The TMA-N value of control, wheat and soybean flour of common carp fish luncheon at zero time was 2.80, 2.47, 2.86mg/ 100g, ww, and it significantly increased ($P\leq 0.05$) at the end of storage period to 8.54, 8.85, 9.15mg/ 100g, ww, for samples stored at 4± 1ºC, and to 9.98, 8.36, 9.05mg/ 100g, ww, for sample stored at 20± 1ºC. Meanwhile, TMA-N content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 3.36, 3.23, 3.96mg/ 100g, ww, and it significantly increased ($P\leq 0.05$) at the end of storage period to 8.52, 7.36, 8.95mg/ 100g, ww, for samples stored at 4± 1ºC, and to 6.87, 6.54, 8.16mg/ 100g, ww, for sample stored at 20± 1ºC. Similar results were reported by **Ghoneim (1978)** and **Farag (2023)**. The upper limit values of 10 to 12mg/ 100g of fish muscle have been established by the **EU (1995)** for fish muscle freshness. The differences between carp and little tuna in TMA-N content may be due to depth, salinity, and temperature of the water where the fish live **(Gillet *et al*., 1997)**.

Table 9. Changes in TMA-N values of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	2.80^{fA}	2.47^{fA}	2.86^{fA}	2.80^{eA}	2.47^{eA}	2.86^{eA}
6	3.35^{dB}	3.71^{eB}	4.45^{eA}	4.54^{dA}	3.91^{dB}	4.95^{dA}
12	4.68^{eB}	4.73^{dB}	5.13^{dA}	5.68^{cA}	4.73^{cB}	5.13^{cA}
18	6.19^{cB}	6.39^{cB}	7.56^{cA}	6.87^{bB}	6.55^{bB}	7.86^{bA}
24	7.85^{bB}	7.66^{bB}	8.75^{bA}	8.98^{aA}	8.36^{aB}	9.05^{aA}
30	8.54^{aB}	8.85^{aB}	9.12^{aA}	R	R	R
	Cooked little tuna fish luncheon					
0	3.36^{eB}	3.23^{eB}	3.96^{eA}	3.36^{dB}	3.23^{dB}	3.96^{dA}
6	4.97^{dB}	4.51^{dB}	5.05^{dA}	4.98^{cA}	4.91^{cA}	5.09^{cA}
12	5.65^{cA}	4.93^{cB}	5.83^{cA}	6.03^{bA}	5.28^{bB}	5.81^{bA}
18	6.76^{bA}	6.49^{bB}	7.56^{bA}	6.87^{aA}	6.54^{aB}	8.16^{aA}
24	8.52^{aA}	7.36^{aB}	8.95^{aA}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests ($P\leq 0.05$); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests ($P\leq 0.05$). R: rejected.

TBA value

Changes in TBA values of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 4± and 20± 1ºC, are provided in Table (10). The results revealed that there were significant differences ($P\leq 0.05$) between control fish luncheon compared with wheat and soybean flour. The TBA value of control, wheat and soybean flour of common carp fish luncheon at zero time was 0.70, 0.79, 0.66mg malonaldhyde/ kg, ww, and it significantly increased ($P\leq 0.05$) at the end of storage period to 3.98, 3.08, 3.79mg malonaldhyde/ kg, ww, for samples stored at 4± 1ºC, and to 3.88, 3.59, 3.69mg malonaldhyde/ kg, ww, for sample stored at 20± 1ºC. Meanwhile, TBA content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 0.96, 0.84, 0.89mg malonaldhyde/ kg, ww, and it significantly increased (*P*≤ 0.05) at the end of storage period to 3.55, 3.32, 3.34mg malonaldhyde/ kg, ww, for samples stored at 4± 1ºC and to 3.93, 3.88, 3.69mg malonaldhyde/ kg, ww, for sample stored at 20± 1ºC. Similar results were reported by **Ghoneim (1978)**, **Ali *et al*. (2017)** and **Farag (2023)**.

Table 10. Changes in TBA contents of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	0.70^{dA}	0.79^{dA}	0.66^{dA}	0.70^{dA}	0.79^{dA}	0.66^{dA}
6	0.88^{dA}	0.92^{dA}	0.79^{dA}	0.93^{dA}	0.98^{dA}	0.82^{dA}
12	1.01^{dA}	1.12^{dA}	0.98^{dA}	1.18^{cA}	1.12^{cA}	1.48^{cA}
18	1.36^{cA}	1.59^{cA}	1.33^{cA}	2.36^{bA}	2.07^{bB}	2.55^{bA}
24	2.78^{bA}	2.85^{bA}	2.50^{bA}	3.88^{aA}	3.59^{aA}	3.69^{aA}
30	3.98^{aA}	3.08^{aB}	3.79^{aA}	R	R	R
	Cooked little tuna fish luncheon					
0	0.96^{eA}	0.84^{eA}	0.89^{eA}	0.96^{dA}	0.98^{dA}	0.89^{dA}
6	1.36^{dA}	1.28^{dA}	1.23^{dA}	1.68^{cA}	1.48^{cB}	1.33^{cA}
12	1.78^{cA}	1.55^{cA}	1.66^{cA}	2.75^{bA}	2.69^{bB}	2.55^{bA}
18	2.33^{bA}	2.09^{bA}	2.18^{bA}	3.93^{aA}	3.88^{aB}	3.69^{aA}
24	3.55^{aA}	3.32^{aA}	3.34^{aA}	R	R	R

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests (*P*≤ 0.05); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests (*P*≤ 0.05). R: rejected.

Microbiological quality of fish luncheon

Total mesophilic bacterial count (TMBC) and total psychrophilic bacterial count (TPBC)

Changes in in total mesophilic bacterial count (TMBC) and total psychrophilic bacterial count (TPBC) as log cfu/ g of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 4± 1ºC, are provided in Table (11). The results revealed that there were significant differences (*P*≤ 0.05) between control fish luncheon compared with wheat and soybean flour.

The TMBC value of control, wheat and soybean flour of common carp fish luncheon at zero time was 2.22, 2.18, 2.28 log cfu/ g, and it significantly increased (*P*≤ 0.05) at the end of storage period to 4.17, 3.64, 3.77 log cfu/ g. While, TMBC content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 3.11, 3.07, 3.17 log cfu/ g, and it significantly increased (*P*≤ 0.05) at the end of storage period to 4.76, 4.23, 4.66 log cfu/ g.

The TPBC value of control, wheat and soybean flour of common carp fish luncheon at zero time was 1.52, 1.45, 1.64 log cfu/g, and it significantly increased (*P*≤ 0.05) at the end of storage period to 3.49, 3.05, 3.18 log cfu/ g. While, TPBC content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 2.01, 1.94, 2.13 log cfu/ g, and it significantly increased (*P*≤ 0.05) at the end of storage period to 4.38, 4.14, 4.70 log cfu/ g. Similar results were reported by **Ghoneim (1978)**, **Talab and Dolganova (2010)** and **Talab (2011)**.

Table 11. Changes in total mesophilic bacterial count (TMBC) and total psychrophilic bacterial count (TPBC) as (log cfu/ g) of cooked common carp and little tuna fish luncheon stored at 4± 1ºC

Storage period (days)	TMBC (log cfu/g)			TPBC (log cfu/g)		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	2.22	2.18	2.28	1.52	1.45	1.64
6	2.87	2.96	2.89	1.93	1.78	1.84
12	3.65	3.57	3.53	2.52	2.43	2.77
18	4.17	3.64	3.77	3.49	3.05	3.18
	Cooked little tuna fish luncheon					
0	3.11	3.07	3.17	2.01	1.94	2.13
6	3.76	3.85	3.78	2.62	2.57	2.73
12	4.24	4.06	4.42	3.41	3.32	3.66
18	4.76	4.23	4.66	4.38	4.14	4.70

Total plate count (TPC)

Changes in in total plat count (TPC) as log cfu/ g of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 20± 1ºC, are provied in Table (12). The results revealed that there were significant differences (*P*≤ 0.05) between control fish luncheon compared with wheat and soybean flour. The TPC value of control, wheat and soybean flour of common carp fish luncheon at zero time was 2.37, 2.30, 2.45 log cfu/ g, and it significantly increased (*P*≤ 0.05) at the end of storage period to 5.46, 4.90, 5.87 log cfu/ g. While, TPC content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 1.87, 1.87, 1.87 log cfu/ g, and it significantly increased (*P*≤ 0.05) at the end of storage period to 4.32, 4.32, 4.32 log cfu/ g. Similar results were reported by **Talab and Dolganova (2010)** and **Talab (2011)**.

Yeast and mold counts (YMC)

Changes in yeast and mold counts (YMC) as log cfu/ g of cooked common carp and little tuna fish luncheon prepared by the addition of starch, flour and soybean flour, stored at 4± 1 and 20± 1ºC, are provided in Table (13).

Table 12. Changes in total plate count (TPC) as log cfu/ g of cooked common carp and little tuna fish luncheon stored at 20± 1ºC

Storage period (days)	*Cooked carp fish luncheon*			*Cooked little tuna fish luncheon*		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
0	2.37	2.30	2.45	1.87	1.87	1.87
6	3.86	3.78	3.83	2.25	2.25	2.25
12	4.15	4.11	4.34	3.48	3.48	3.48
18	5.46	4.90	5.87	4.32	4.32	4.32

Table 13. Changes in yeast and mold counts (YMC) as log cfu/ g of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	1.28	1.30	1.34	1.28	1.30	1.34
6	1.75	1.82	1.95	2.19	2.22	2.34
12	2.43	2.24	2.78	2.87	2.76	2.95
18	3.95	3.78	3.23	3.33	3.06	3.54
	Cooked little tuna fish luncheon					
0	2.17	2.19	2.23	2.17	2.19	2.23
6	3.08	3.11	3.23	2.47	2.35	2.36
12	3.76	3.65	3.84	2.52	2.40	3.03
18	4.22	3.95	4.43	2.78	2.69	3.26

The results revealed that there were significant differences ($P \leq 0.05$) between control fish luncheon compared with wheat and soybean flour. The YMC value of control, wheat and soybean flour of common carp fish luncheon at zero time was 1.28, 1.30, 1.34 log cfu/ g, and it significantly increased ($P \leq 0.05$) at the end of storage period to 3.95, 3.78, 3.23 log cfu/ g for samples stored at 4± 1ºC and to 3.33, 3.06, 3.54 log cfu/ g for sample stored at 20± 1ºC. Meanwhile, YMC content of control, wheat and soybean flour of little tuna fish luncheon at zero time was 2.17, 2.19, 2.23 log cfu/ g, and it significantly increased ($P \leq 0.05$) at the end of storage period to 4.22, 3.95, 4.43 log cfu/ g for samples stored at 4± 1ºC and to 2.78, 2.69, 3.26 log cfu/ g for sample stored at 20± 1ºC. Similar results were reported by **Talab and Dolganova (2010)** and **Talab (2011)**. According to the Egyptian Standard Specification for luncheon meat **ESS (2005)**, all samples did not exceed the acceptability limit proposed by **Connell (1990)** and set by the **EU (1995)** for fish quality assessment.

Over acceptability scores

Changes in over acceptability scores of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC, are provied in Table (14). The results revealed that there were significant differences (*P*≤ 0.05) between control fish luncheon compared with wheat and soybean flour. On the other hand, sensory properties of fish luncheon were reduced (*P*≤ 0.05) by storage time.

Table 14. Changes in over acceptability scores of cooked common carp and little tuna fish luncheon stored at 4± 1 and 20± 1ºC

Storage period (days)	Storage at 4± 1ºC			Storage at 20± 1ºC		
	Starch	Wheat	Soybean	Starch	Wheat	Soybean
	Cooked carp fish luncheon					
0	9.40^{aA}	9.85^{aA}	9.27^{aA}	9.40^{aA}	9.85^{aA}	9.27_{aB}
6	9.10^{aA}	9.50^{aA}	9.08^{aA}	8.58^{bA}	8.93^{bA}	8.35^{bB}
12	8.94^{aA}	9.03^{aA}	8.89^{aA}	7.75^{cA}	7.80^{cA}	7.48^{cA}
18	$8. 78^{aA}$	8.88^{aA}	8.66^{aA}	7.10^{dA}	7.18^{dA}	6.70^{dB}
	Cooked little tuna fish luncheon					
0	8.13^{aA}	8.25^{aA}	8.00^{aB}	8.13^{aA}	8.25^{aA}	8.00^{aA}
6	7.14^{bA}	7.55^{bA}	6.91^{bB}	7.14^{bA}	7.43^{bA}	6.91^{bA}
12	6.91^{bB}	7.22^{bA}	6.77^{bB}	6.31^{cB}	7.02^{cA}	6.04^{cB}
18	6.00^{cB}	6.74^{cA}	5.66^{cB}	5.41^{dB}	6.54^{dA}	4.93^{dB}

Means followed by different small letters in the same column (effect of storage period) are significant by Duncan´s multiple tests (*P*≤ 0.05); Means followed by different capital letters in the same raw (effect of treatments) are significant by Duncan´s multiple tests (*P*≤ 0.05). R: rejected.

The over acceptability scores of control, wheat and soybean flour of common carp fish luncheon at zero time was 9.40, 9.85, 9.27, and it significantly decreased (*P*≤ 0.05) at the end of storage period to 8.78, 8.88, 8.66 for samples stored at 4± 1ºC, and to 7.10, 7.18, 6.70 for sample stored at 20± 1ºC. Meanwhile, over acceptability scores of control, wheat and soybean flour of little tuna fish luncheon at zero time was 8.13, 8.25, 8.00, and significantly decreased (*P*≤ 0.05) at the end of storage period to 6.00, 6.74, 5.66 for samples stored at 4± 1ºC, and to 5.41, 6.54, 4.93 for sample stored at 20± 1ºC. According to the sensory evaluation it could be noticed that, wheat flour treatment was the best compared to starch and soybean flour. Similar results were reported by **Ghoneim (1978)**, **Ali *et al*. (2017)** and **Farag (2023)**.

CONCLUSION

According to the sensory evaluation it could be noticed that wheat flour treatment is the best compared to starch and soybean flour. Cooked common carp and little tuna fish luncheon stored at cold and ambient temperatures did not exceed the maximum permissible limits set by national and international specification and safe for human consumption.

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