Techno-Science Research Journal V:12 (2)(2024) P 71-77

Content list available at ITC

Techno-Science Research Journal

Journal Homepage: http://techno-srj.itc.edu.kh/

Techno-Science Research Journal

Evaluate the Potential Changes in Physico-Chemical and Microbiological Quality of Spicy Sour Seasoning during Storage

Davin Pheap[1, 2], Seanghai Hoeun[1], Elen Morm[1], Sokneang In[1*]

[1] *Faculty of Food and Chemical Engineering, Institute of Technology of Cambodia, Russian Federation Blvd., P.O. Box 86, Phnom Penh, Cambodia*

[2] *Graduate School, Institute of Technology of Cambodia, Russian Federation Blvd., P.O. Box 86, Phnom Penh, Cambodia*

Received: 03 November 2023; Revised:16 February 2024 Accepted: 18 March 2024; Available online: December 2025

Abstract: *Seasoning powder is commonly made from different ingredients including salt, sugar, monosodium glutamate, spices and others. The objective of this study aimed to observe the potential changes in physicochemical and microbiological quality of formulated seasoning powder during storage at room temperature for 90 days with sealing and vacuum packed. Dried ingredients such as chili, galangal, garlic, green tamarind, mushroom, onion, river-leaf creeper, and shrimp were mixed with salt, sugar and monosodium glutamate prepared into 3 formulation G3C0.5, G3C1.5, and R3C0.5. Statistical comparisons were performed with one-way ANOVA and p values < 0.05 were regarded as significant difference. The nutritional value of the formulated seasoning on day 0 and day 90 were insignificantly difference (P>0.05) and was found 13.07% to 12.22%, 25.97% to 28.37%, 51.46% to 62.46%, 1.67% to 3.00%, and 4.75% to 9.87% of protein, ash content, carbohydrate, lipid, and fiber, respectively. The physicochemical and microbiological quality from day 0 to day 90 were significantly difference (P<0.05) that increases from 4.04% to 10.27% of moisture content, 3.55 to 3.82 of pH value, 0.36 to 0.50 of aw, 1.70 to 11.66 of different color (ΔE), 2.1×103 to 32.8×103 CFU/g of TPC, and 1.3×102 to 11.8×102 CFU/g of TYMC, accordingly. However, the physicochemical and microbiological quality were acceptable based on the dry product specification, and the formulated seasoning can keep longer than 90 days at room temperature in vacuum-packed and sealing packed.*

Keywords: Seasoning, Physico-chemical quality, Microbiological quality, Storage

1. INTRODUCTION

Spices and seasonings are mostly used to enhance taste, and improve the color, texture, nutritional content or shelf life of foods and beverages [1]. Seasoning is a combination of several flavoring ingredients include sugars, salts, spices, and/or herbs [2]. However, spices are often used in their dried forms because they are not subject to seasonal availability, easily to process, have a longer shelf life, and lower cost [3]. Drying involves heat and mass transfer process and also an important tool process used in agricultural product preservation. This method helps preserve food in a stable and safe condition by reducing water activity, extending the shelf life much longer than that of fresh products. The drying techniques include sun drying, hot air drying, and some other drying techniques [4].

Many people add seasoning in the foods for their daily life. Also in Cambodia, most of the seasoning was imported from other countries such as Thailand, Japan, China, etc. However, not many local seasoning powder products are found in Cambodia's market. In addition, a deep study on the development and quality of seasoning is still limited in Cambodian.

In this research, two main ingredients were used to provide the sour taste of seasoning including green tamarind (GT) and river-leaf creeper (Rlc),. Then, the seasons were added with other ingredients such as onion, galangal, garlic, mushrooms, shrimp, sugar, and salt [5]. Monosodium glutamate is also utilized to improve umami taste [6] .

Therefore, this study is conducted with two main objectives: to develop spicy sour seasoning using two different types of sourness source; and to study the stability

* Corresponding author: Sokneang In
E-mail: in@itc.edu.kh; Tel: +855- 12 447 898

of developed seasoning in term of physico-chemical and microbiological property changes during 90 days of storage time in two different types of packaging at the room temperature..

2. METHODOLOGY

2.1 Sample preparation

Fresh raw materials such as chili, galangal, garlic, green tamarind mushroom, onion, river-leaf creeper and shrimp were purchased in April 2023 from Dermkor market, Phnom Penh, Cambodia. The raw materials were cleaned, peeled, sliced, and then oven-dried at 65°C for different conditions, 5 hours for river-leaf creeper, 10 hours for mushroom, 16 hours for galangal, green tamarind, and chili, and 24 hours for shrimp, garlic, and onion.

2.2 Seasoning Formulations

First step, all 8 ingredients were mixed and separated to three different formulations as showed in Table. 2.1.

Table. 2.1. Ingredient composition of seasoning formulation in grams

Formulation	$G_3C_{0.5}$	$G_3C_{1.5}$	$R_3C_{0.5}$
Chili powder	5	15	5
Galangal powder	10	10	10
Garlic powder	10	10	10
GT powder	30	30	-
MSG	5	5	5
Mushroom powder	10	10	10
Onion powder	10	10	10
Rlc powder	-	-	30
Salt	20	20	20
Shrimp powder	10	10	10
Sugar	10	10	10

The ratio of 3 formulated including 1:0.5:3 (G1

The ratio of 3 formulated including 1:0.5:3 (G1: C: GT) or abbreviation G3C0.5, 1:1.5:3 (G1: C: G) or abbreviation G3C1.5, and 1:0.5:3 (G1: C : R) or abbreviation R3C0.5. Where G1 presented the ratio of 5 ingredients such as galangal, garlic, mushroom, onion and shrimp. C, G, and R presented of chili, green tamarind, and river-leaf creeper, respectively.

2.3 Stability study

Three formulated spicy sour seasonings were packed in poly coated brown craf paperbag (Kraft Paper Ziplock Window Pouch Bag 10x15cm) with two different ways of packing such as sealing packed and vacuum packed and then stored in the room temperature. The physicochemical and microbiological properties of the seasoning were observed for day 0, 0, 3, 7, 14, 30, 60, and 90.

2.4 Physicochemical properties of formulated seasoning analysis

The moisture of those samples were determined by following the method of Association of Official Agricultural Chemists, 1975 [7], where the dried samples were weigh 3g to aluminium dish and place in oven at 105°C until stable weight. Ash content of each sample were determined by heating at 550ºC for 3 hours [8]. The pH value of each sample were measured by using PH METER HORIBA LAQUA model F-72G and following the method AOAC 981.12 [9]. The water activity were measured by water activity meter aqualab [10]. In addition, fiber content was analyzed by ceramic fiber filter method (AOAC 920.169 or 962.09). The calculatation of those parameter were follow the formular below.

$$\text{Moisture (\%)} = ((M_s - (M_f - M_{al})) / M_s) \times 100 \quad \text{(Eq.1)}$$

$$\text{Ash (\%)} = ((M_f - M_{pc})/M_s) \times 100 \quad \text{(Eq.2)}$$

Where M_s is mass of sample, M_{al} is mass of aluminium dish, M_{pc} is mass of porcelain cup, M_f is mass of sample with porcelain cup or alumunium dish after heating.

$$\text{\% Fiber} = [(W_2 - W_1) - (W_4 - W_3)]/W \times 100 \quad \text{(Eq.3)}$$

Where W is mass sample, W_1 is mass fiber bag, W_2 is mass of sample after dry in oven 105°C, W_3 is mass of porcelain and W_4 is mass of sample after furanced at 550°C.

Color measurement of seasoning was measured by Bench-top Spectrophotometer CM-5. The data of its color was shown in CIE L*, a*, and b* value that represent of L* is (+) lightness or (-) brightness, a* is (+) redness or (-) greenness and b* is (+) yellowness or (-) blueness. It was measured in triplicate and all the results were shown on average. The determination of color different was calculated with the following formula bellow.

$$\Delta E = \sqrt{(L_0 - L^*)^2 + (a_0 - a^*)^2 + (b_0 - b^*)^2} \quad \text{(Eq. 4)}$$

Where

L_0 (fresh), L^* (dried): whiteness or brightness
a_0 (fresh), a^* (dried): (+) redness or (-) greenness
b_0 (fresh), b^* (dried): (+) yellowness or (-) blueness
ΔE: Total color difference

The formulated seasoning was analyzed the lipid, protein, and carbohydrate content. The lipid content was analyzed by Soxhlet extaction (AOAC 2003.05). About one gram of seasoning was placed in an empty plate, and then added with 70ml of n-hexane. The extraction was conducted at 130°C for 30min by a crucible immersing in boiling solvent, 60 min for washing, and 15 min for recovery. After extraction, the vessel with boiling stones was place in an

oven at 105°C until the stable mass was obtained. The dried vessel was kept in the desiccator to cool down, and then weighted.

The protein content was determined by Kjeldahl method (AOAC 960.52). About one gram of seasoning sample was put into a digestion tube, and then added with 10 grams of 2 Kjeldahl tablets, and 20 mL of 98% H2SO4. The digestion system (SpeedDigester, model K-436, brand Buchi) was preheated at 420°C and the samples were digested for 90 min. After extraction, the samples were cooled down at the room temperature. The digested sample was placed in the protein distillation apparatus (model K-365), and 20 ml of 32% NaOH was added. The ammonia evolved was received in 10 ml of 4% Boric acid solution, then dropped with a few methyl blue indicators and titrated with 0.25M of H2SO4 until the color turned to light pink. Carbohydrate was determined by calculation method following the Eq.7 (AOAC 986.25,2012).

$$\%Fat = [(W2-W0)]/W1 \times 100 \quad \text{(Eq.5)}$$

Where $W0$ is the mass of empty plate, $W1$ is the mass of sample and the $W2$ is the mass of the plate with extract oil.

$$W(N) = [(V(1)-V(Bl))\times F\times c\times f\times M(N)]/(m\times 1000) \quad \text{(Eq.6.1)}$$

$$\%N = W(N)\times 100 \quad \text{(Eq.6.2)}$$

$$\%P = W(N) \times PF\times 100 \quad \text{(Eq.6)}$$

Where W(N) is weight fraction of nitrogen, V(1) is amount of titrant for the sample, V(Bl) is mean amount of titrant for the blank, F is molar reaction factor (2 for H2SO4), c is concentration of the titrant, f is factor of the titrant, M(N) is molecular weight of nitrogen, m is sample weight 1000 is conversion factor, PF is protein factor, %N is percentage of weight of nitrogen, %P is percentage of weight of protein.

$$\%Carbohydrate = 100 - \%(moisture + ash + protein + lipid) \quad \text{(Eq.7)}$$

2.5 Microbiological analysis

Ten grams of formulated seasoning were diluted in 90 ml of sterile saline water (10^{-1}) then pumped 1 ml into test tube 10 ml (Pyrex glass capped SV) of 9 ml sterile saline water to serially diluted (10^{-2}, 10^{-3}, 10^{-4}, and 10^{-5}). The agar used included Plate Count Agar for the total bacteria count (total plate count, TPC) and Potato Dextrose Agar for total yeast and mold counts (TYM). Both sterile agar solution (media) was poured in petri dishes then 0.1ml of diluted samples were placed in duplicate on petri dishes. Both plates of TPC and TYM were incubated at 35°C for 24 hours before counting [11]. The number colony forming unit per milliliter was calculated with the following formula:

$$\text{Bacteria num. (cfu/g)} = \frac{Number\ of\ colonies \times DF}{Volume\ of\ culture\ plate} \quad \text{(Eq. 8)}$$

2.6 Statistical analysis

All analysis was done in duplicates (n=2) and these values were then represented as average values along with their standard derivations (mean ± STD). Data were analyzed using the Minitab software. Statistical comparisons were performed with one-way ANOVA and p values < 0.05 were regarded as significant difference.

1. RESULTS AND DISCUSSION

1.1 Nutritional value of spicy sour seasoning

Table 3.1. Nutritional value in seasoning (D0 and D90)

Sample	Protein (%)	Ash (%)	Carbohydrate (%)	Lipid (%)	Fiber (%)
			Day 0		
$G_3C_{0.5}$	13.07±0.40^a	28.37±0.02^a	51.46±0.79^a	1.67±0.13^a	8.43±0.37^a
$G_3C_{1.5}$	12.92±0.31^a	25.97±0.04^a	53.56±0.38^a	2.27±0.27^a	9.87±0.38^a
$R_3C_{0.5}$	3.05±0.16^a	27.53±0.02^a	62.46±0.23^a	3.00±0.07^a	5.06±0.68^a
			Day 90		
$SG_3C_{0.5}$	12.22±0.29^a	27.34±1.05^a	48.78±0.97^b	1.68±0.12^a	8.02±0,03^a
$SG_3C_{1.5}$	12.16±0.30^a	24.23±0.16^b	51.03±0.31^b	2.30±0.12^a	9.08±0.09^a
$SR_3C_{0.5}$	2.07±0.14^b	26.06±0.71^a	60.34±0.12^b	3.03±0.11^a	4.65±0.32^b
$VG_3C_{0.5}$	12.20±0.31^a	27.78±1.12^a	50.07±0.68^{a,b}	1.67±0.19^a	8.14±0.15^a
$VG_3C_{1.5}$	12.17±0.27^a	24.64±0.73^{a,b}	51.11±0.17^b	2.29±0.14^a	9.52±0.24^a
$VR_3C_{0.5}$	2.07±0.16^b	26.26±0.47^a	61.19±0.41^b	3.02±0.10^a	4.70±0.25^b

Letter S and V represented Sealing packed and Vacuum packed, respectively. $G_3C_{0.5}$, $G_3C_{1.5}$, and $R_3C_{0.5}$ represented formulation of green tamarind with chili ratio (3:0.5), green tamarind with chili ratio (3:1.5), and River-leaf creeper with chili (3;0.5), respectively. Different letters in column represent statistically significant differences ($p \leq 0.05$) between samples storage for 90 day

The nutritional value in the selected products of spicy sour seasoning was investigated for 0 and 90 days, and shown in Table 3.1. Through the value of experiment, seasoning formulated with green tamarind were higher protein and fiber content than formulated of river-leaf creeper, however carbohydrate and lipid content in formulated of river-leaf creeper were higher than formulated with green tamarind. Nutritional value such as protein ($G_3C_{0.5}$ and $G_3G_{1.5}$), carbohydrate ($G_3C_{0.5}$), lipid, fiber, and ash ($G_3C_{0.5}$, $G_3G_{1.5}$, and $R_3C_{0.5}$) were insignificantly different ($P>0.05$) when storage in both sealing and vacuum packed for 90th days. Excepted protein content of condition $R_3C_{0.5}$ and carbohydrate content of formulated ($G_3G_{1.5}$ and $R_3C_{0.5}$) were significantly different ($P<0.05$) when storage for 90days. However, the value thus formulated didn't much change from day 0 to day 90, as seen in Table 3.1.

1.2 Change in color during storage

The L*, a*, and b* value refer to lightness, redness/greenness, and yellowness/blueness respectively. For the storage time from day 0 to day 90, the colors of the samples stored in both packaging were significantly different ($p< 0.05$). The CIE color values indicated that both sealed and vacuum-packed were affected by light, inducing color changes during storage [12].

Table 3.2. The value of L*,a*, and b* of seasoning

Sample	Day 0		
	L*	a*	b*
$G_3C_{0.5}$	70.87±0.01	11.05±0.01	33.16±0.01
$G_3C_{1.5}$	69.14±0.01	16.39±0.01	37.42±0.01
$R_3C_{0.5}$	66.39±0.00	3.84±0.01	31.49±0.01
	Day 90		
$SG_3C_{0.5}$	60.22±0.01	12.62±0.00	36.86±0.01
$SG_3C_{1.5}$	58.08±0.04	17.91±0.05	40.76±0.01
$SR_3C_{0.5}$	57.17±0.04	5.57±0.1	34.03±0.01
$VG_3C_{0.5}$	61.46±0.04	12.35±0.03	35.91±0.04
$VG_3C_{1.5}$	59.93±0.04	17.76±0.04	39.72±0.01
$VR_3C_{0.5}$	59.14±0.05	5.48±0.04	33.81±0.68

ΔE value in Fig. 3.1. were the total color difference or the distance between colors. The lowest ΔE value of processing samples was the good condition in preserving color of spices compared to the color of a fresh raw material or freshly prepared sample [13]. Statistical test revealed that after storage for 90 days, all the color of formulated seasoning were significantly different ($p<0.05$) from freshly formulated spicy sour seasoning in both sealing-packed and vacuum-packed. The samples stored in vacuum packaging showed a lower in AE value because of lower moisture content and oxygen that are limited the growth of TPC, and TYMC. The value of ΔE increasing range from 1.89±0.03 to 11.65±0.05 for sealing packed and vacuum packed range from 1.70±0.03 to 9.89±0.04.

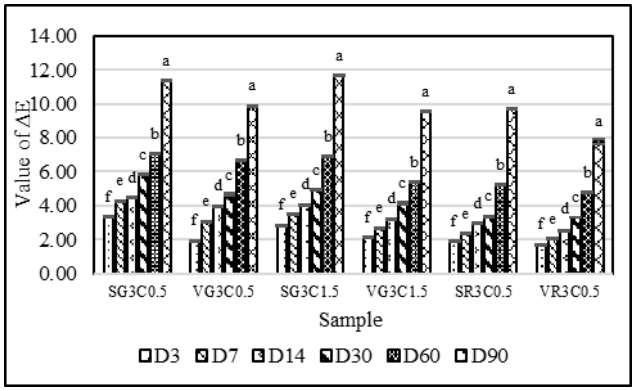

Fig.3.1. The color different (ΔE) during storage of spicy sour seasoning

Letter S and V represented Sealing packed and Vacuum packed, respectively. $G_3C_{0.5}$, $G_3C_{1.5}$, and $R_3C_{0.5}$ represented formulation of (green tamarind: chili) ratio (3:0.5), (green tamarind: chili) ratio (3:1.5), and (River-leaf creeper: chili) ratio (3:0.5), respectively.

The study of Modi et al., 2006 [14] were detail that changes in visual color (reflectance) of spices are reported to be dependent on the method of processing, packaging conditions, degree of exposure to light, increase of moisture content, and interaction of ingredient.

1.2 Change in moisture content during storage

The change in moisture content during storage were shown in Fig 3.2.

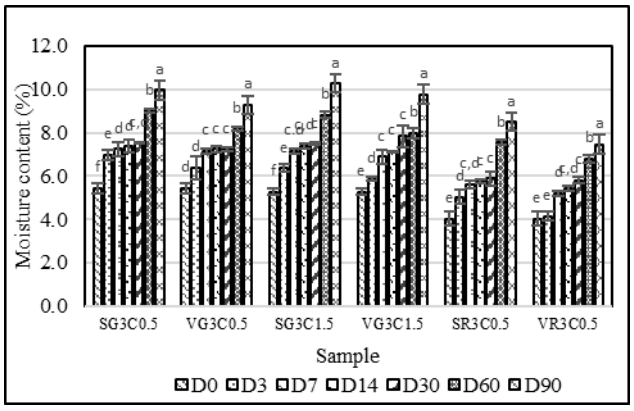

Fig.3.2. Change of moisture content during storage of spicy sour seasoning

Letter S and V represented Sealing packed and Vacuum packed, respectively. $G_3C_{0.5}$, $G_3C_{1.5}$, and $R_3C_{0.5}$ represented formulation of green tamarind with chili ratio (3:0.5), green tamarind with chili ratio (3:1.5), and River-leaf creeper with chili (3;0.5), respectively.

During storage at room temperature for 90 days, moisture content of the seasoning in formulated $G_3C_{0.5}$ increase from 5.44±0.23% to 9.66±0.32% and 9.29±0.39% for sealing packed and vacuum packed, respectively. For the formulated $G_3C_{1.5}$, moisture content was increased from 5.28±0.17% to 10.27±0.05% for sealing packed and 9.78±0.61% for vacuum packed.

The last formulated of seasoning $R_3C_{0.5}$ were increased from 4.04±0.33% to 8.50±0.35% for sealing packed and the 7.46±0.32% for vacuum packed. The moisture content of all condition was significantly different ($p<0.05$). Seasoning are hygroscopic in nature, because they are very sensitive to moisture [15], the moisture content was easily increased during storage which causes by moisture absorption from the air inside the package and water vapor transfer from the storage environment until reaching the balance between moisture and the water holding capacity of the samples.

The moisture also possibly increase through air intake from the package seal [16]. According to the Codex Standard and other studies, the moisture content of the final product of dried food should range between 5% and 12% to prevent the proliferation of fungi [17]. Thus, the moisture

content of all formulated seasoning was below the standard limit (12%) after 90 days of storage.

1.3 Change in water activity during storage

Water activity is a measure of the amount of free water in a sample and is usually expressed as an a_w or percentage of Equilibrium Relative Humidity (%ERH) and an important factor for the growth of micro-organisms, chemical stability and enzymatic activity of foods. Following an increased in moisture content, water activity also increased in samples during storage for 90 days (Fig 3.3). The a_w value of spice formulated condition $G_3C_{0.5}$ were increased from 0.44±0.00 to 0.49±0.01 and 0.46±0.02 of sealing packed and vacuum packed, respectively. The $G_3C_{1.5}$ was found value of a_w increased from 0.42±0.00 to 0.48±0.00 for sealing packed and to 0.43±0.00 for vacuum packed. The last formulation of spicy sour seasoning was increased from 0.36±0.00 to 0.47±0.00 for sealing packed and 0.43±0.00 for vacuum packed.

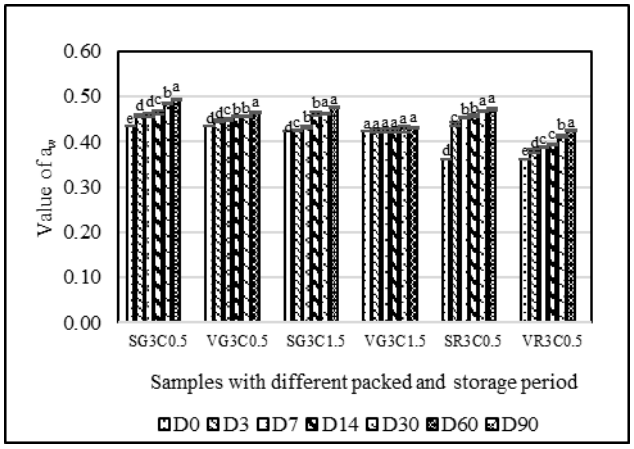

Fig.3.3. Change of water activity during storage of spicy sour seasoning

Letter S and V represented Sealing packed and Vacuum packed, respectively. $G_3C_{0.5}$, $G_3C_{1.5}$, and $R_3C_{0.5}$ represented formulation of green tamarind with chili ratio (3:0.5), green tamarind with chili ratio (3:1.5), and River-leaf creeper with chili (3;0.5), respectively.

The condition of $G_3C_{1.5}$ was not significantly different ($p>0.05$), and the other conditions were significantly different ($p<0.05$). An increase in a_w of seasoning during storage could be due to the concomitant increase in moisture content. In other studies, it was detailed that all a_w measurements in foods will be <1.0 (Gurtler et al., 2014). Whereas, the legal standard (codex standard) said that proper drying of spices to achieve a water activity below 0.60 is adequate to prevent mycotoxin production because at lower water activity of 0.60, there is hardly any mold growth.

1.4 Change in pH value during storage

The pH of the spices can be reduced to prevent the pathogens growth. Change of pH value in seasoning were show in Fig.3.5. pH value of $G_3C0.5$, G3C1.5, and R3C0.5 during 90 days period were in the range of 3.55±0.01 to 3.63±0.04, 3.63±0.01 to 3.71±0.03 and 3.75±0.01 to 3.82±0.01 for product packed by sealing. During storage for 90 day, the pH of seasoning that packed by sealing were significantly difference ($p<0.05$), whereas the pH of seasoning in the vacuum-packed conditions was not significantly different ($p>0.05$). The pH value was slightly increased to 3.61±0.02, 3.64±0.01, and 3.80±0.03 of G3C0.5, G3C1.5, and R3C0.5, respectively.

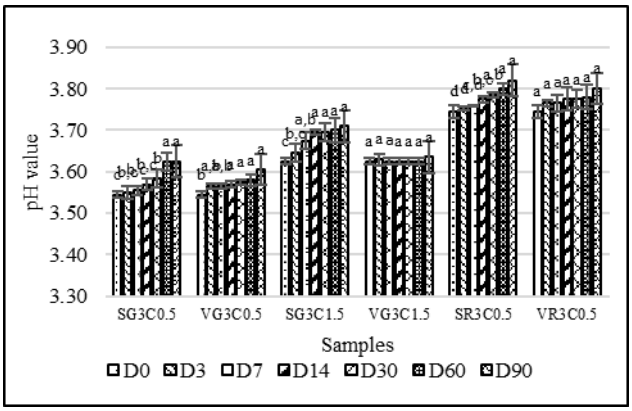

Fig.3.4. Change of pH during storage of spicy sour seasoning

Letter S and V represented Sealing packed and Vacuum packed, respectively. $G_3C_{0.5}$, $G_3C_{1.5}$, and $R_3C_{0.5}$ represented formulation of green tamarind with chili ratio (3:0.5), green tamarind with chili ratio (3:1.5), and River-leaf creeper with chili (3;0.5), respectively.

In other study, the pH of freshly prepared spice mix was 4.0±0.11which decreased gradually to 3.7±0.05 and to 3.6±0.04 when stored for 6 months at 27°C and at 37°C, respectively [14]. However, the elevation in pH indicates the loss of quality and most microorganisms grow the best at pH values between 6.6 and 7.5. While the pH value of formulation seasoning in the range of 3.55 to 3.82, therefore, all of seasoning were in the acceptable range at the end of 90 days period.

1.5 Change in microbial count during storage

The value of microbial count such as total plate count and total yeast and mold in formulated seasoning during storage for 90 days were shown in Table 3.2 and Table 3.3.. The microbiological quality from both sealing and vacuum packed seasoning were significantly different ($P<0.05$) from day 0 to day 90.

Table. 3.2. The growth of total plate count in formulated spicy sour seasoning from day 0 to day 90.

		TPC (10^3 CFU/g)						
		D0	**D3**	**D7**	**D14**	**D30**	**D60**	**D90**
Sealing	$G_3C_{0.5}$	2.10	4.90	8.00	11.25	13.0	15.45	18.4
	$G_3C_{1.5}$	3.35	16.45	19.45	24.55	25.5	27.5	32.8
	$R_3C_{0.5}$	6.25	7.40	8.90	9.05	11.5	13.0	16.7
Vacuum	$G_3C_{0.5}$	2.10	2.15	4.85	7.95	9.30	9.85	11.2
	$G_3C_{1.5}$	3.35	4.35	5.20	8.95	9.15	12.0	13.4
	$R_3C_{0.5}$	6.25	6.45	6.65	7.20	7.85	8.00	8.8

Table. 3.3. The growth of total yeast and mold in formulation spicy sour seasoning from day 0 to day 90

		TYM (10^2 CFU/g)						
		D0	**D3**	**D7**	**D14**	**D30**	**D60**	**D90**
Sealing	$G_3C_{0.5}$	1.25	2.25	3.65	4.1	6.2	8.5	9.2
	$G_3C_{1.5}$	2.3	6.55	7.6	8.25	9.0	10.1	11.8
	$R_3C_{0.5}$	1.45	4.85	5.2	5.6	6.0	7.0	8.25
Vacuum	$G_3C_{0.5}$	1.25	1.7	2.25	3.55	4.15	5.45	6.5
	$G_3C_{1.5}$	2.3	2.6	3.1	3.8	5.55	7.5	8.9
	$R_3C_{0.5}$	1.45	2.75	2.8	3.25	4.2	4.8	6.1

Kilcast and Subramaniam (2000) [18] detailed that the growth of a specific microorganism during storage depends on several factors, the most important being: the initial microbial loading at the start of storage; the physicochemical properties of the food, such as moisture content, pH, presence of preservatives; the processing method used in the production of the food; and the external environment of the food, such as the surrounding gas composition and storage temperature.

According to the Regulations of the Head National Food and Drug Agency Number 16 in 2016, the maximum total plate number on spices and condiments in ready-to-use pasta (wet) is 10^4 colonies per gram. However, the International Microbiological Standard recommended the limit for bacteria contaminants in spices are in the range of 10^1 to 10^5 cfu/g for the total microbial plate count and 10^1 to 10^3 cfu/g for yeast and mold [19]. Based on the microbial count in all formulated seasonings, the amount was in the recommended rang, therefore it could be consumed and preserved for 90 days.

2. CONCLUSION

The developed spicy sour seasoning had 3 different conditions such as $G_3C_{0.5}$, $G_3C_{1.5}$, and $R_3C_{0.5}$. The moisture content, water activity, pH, and color difference (ΔE) slightly increased from day 0 to day 90 for both sealing and vacuum packed condition. Nutritional values were not significantly different by storage duration. The microbiological quality such as total plate count and total yeast and mold were significantly difference ($p<0.05$) from day 0 to day 90. However, the moisture content, pH value, water activity, color difference (ΔE), TPC and TYMC were found higher in sealed-packed rather than in vacuum-packed ($P<0.05$). Based on the dry product specification [19], the three formulated seasoning stored in sealed and vacuum packaging could be consumed and preserved for 90 days.

ACKNOWLEDGMENTS

The authors are thankful to Higher Education Improvement Project (HIEP Credit No: 6221-KH) for financial support and Faculty of Food and Chemical Engineering, Institute of Technology of Cambodia which provide equipment for conducting the research.

REFERENCES

[1] J. W. Parry, *BOOK SPICES pages from 9780820603780_txt.pdf.* Chemical Publishing Company, Inc., 1969.

[2] M. Mahendradatta, A. B. Tawali, F. Bastian, M. Tahir, F. Science, and T. S. Program, "Optimizing Production Process of Seasoning Powder," ESEVIER, 1996.

[3] S. Raghavan, *Handbook of Spices, Seasonings, and Flavorings.* CRC Press, 2006, doi: 10.1201/b13597.

[4] U. E. Inyang, I. O. Oboh, and B. R. Etuk, "Kinetic Models for Drying Techniques—Food Materials," *Advances in Chemical Engineering and Science,* vol. 8, no. 2, pp. 27–48, 2018, doi: 10.4236/aces.2018.82003.

[5] C. Gadegbeku and B. Atsu, "Herbs, Spices, Seasonings and Condiments used by food vendors," *Caribbean Journal of Science and Technology,* vol. 2, pp. 589–602, 2014.

[6] C. Suwankanit, S. Pandolsook, V. Vittayaporn, and K. Tohtubtiang, "Influences of Different Soup Stocks on Chemical and Organoleptic Properties of Tom Yum," *Journal of Science and Technology, Ubon Ratchathani University,* vol. 17, no. 3, pp. 56–70, 2014.

[7] Association of Official Agricultural Chemists, "Official Methods of Analysis," in *Wood Chemistry and Wood Biotechnology,* pp. 124–130, 1975.

[8] H. W. Wiley, "Association of Official Agricultural Chemists," *Science,* vol. ns-8, no. 178, p. 14, 1886, doi: 10.1126/science.ns-8.178.14.a.

[9] F. E. Boland, R. C. Lin, T. R. Mulvaney, F. D. McClure, and M. R. Johnston, "pH Determination in acidified foods: collaborative study," *Journal of the Association of Official Analytical Chemists,* vol. 64, no. 2, pp. 332–336, 1981, doi: 10.1093/jaoac/64.2.332.

[10] F. E. Boland, R. C. Lin, T. R. Mulvaney, F. D. McClure, and M. R. Johnston, "pH Determination in acidified foods: collaborative study," *Journal of the Association of Official Analytical Chemists,* vol. 64, no. 2, pp. 332–336, 1981, doi: 10.1093/jaoac/64.2.332.

[11] F. A. M. Al-Dhabaan and A. H. Bakhali, "Analysis of the bacterial strains using Biolog plates in the contaminated soil from Riyadh community," *Saudi Journal of Biological Sciences,* vol. 24, no. 4, pp. 901–906, 2017, doi: 10.1016/j.sjbs.2016.01.043.

[12] S. K. Karn, V. Chavasit, R. Kongkachuichai, and N. Tangsuphoom, "Shelf stability, sensory qualities, and bioavailability of iron-fortified Nepalese curry powder," *Food and Nutrition Bulletin,* vol. 32, no. 1, pp. 13–22, 2011, doi: 10.1177/156482651103200102.

[13] R. N. Abeyta, "The distance between Colors; Using DeltaE* to determine which colors are compatible," *Dissertations and Theses,* vol. 9, pp. 1–62, 2011.

[14] V. K. Modi, G. S. Sidde Gowda, P. Z. Sakhare, N. S. Mahendrakar, and D. Narasimha Rao, "Pre-processed spice mix formulation and changes in its quality during storage," *LWT - Food Science and Technology,* vol. 39, no. 6, pp. 613–620, 2006, doi: 10.1016/j.lwt.2005.05.004.

[15] R. Shabir Ahmad, M. Imran, M. Kamran Khan, M. Haseeb Ahmad, M. Sajid Arshad, H. Ateeq, and M. Abdul Rahim, "Introductory Chapter: Herbs and Spices - An Overview," in *Herbs and Spices - New Processing Technologies,* 2021, doi: 10.5772/intechopen.100725.

[16] R. Kumar and S. C. Samsher, "Studies on proximate analysis of biscuits using multigrain flours during ambient condition," *International Journal of Food Science and Nutrition,* vol. 1, no. 2, pp. 39–41, 2016.

[17] Codex Alimentarius, "Proposed draft code of practice for the prevention and reduction of mycotoxin contamination in spices," March 2015, pp. 18, 2016.

[18] D. Kilcast and P. Subramaniam, *The Stability and Shelf-Life of Food: Fruits and Vegetables,* 2000.

[19] S. Parveen, S. Das, A. Begum, N. Sultana, M. M. Hoque, and I. Ahmad, "Microbiological quality assessment of three selected spices in Bangladesh," *International Food Research Journal,* vol. 21, no. 4, pp. 1327–1330, 2014.