Research for stability of food products and functional foods

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Abstract

The study uses rapid aging and real-condition methods to assess the stability of frozen meat, yogurt and functional foods. The method of real conditions is applied to frozen meat and yogurt with the following factors being: temperature: -20°C ± 2°C; humidity: 100% for frozen meat and temperature: 4°C ± 2°C; humidity: > 80% for yogurt. The accelerated aging method is applied to functional foods in conditions: 35 ± 2°C, 45 ± 2°C, 55 ± 2°C, and humidity: 70 ± 5% in parallel assessment combination with real-time monitoring at 25 ± 2°C, and humidity 70 ± 5%. The results showed that the yogurt sample reached stability until the 45th day and did not reach from the 47th day due to layering and deposits at the bottom of the box. The frozen meat sample remained stable when monitored until the 12.6 months with all indicators. Functional food samples were estimated to reach stability of up to 40.3 months when using the Van't Hoff formula, 32.0 months when using the Q10 coefficient, and 36.8 months when monitored in real conditions. The results of the study indicate that the less stable criteria on each sample background are the basis for selecting evaluation criteria for subsequent studies that contribute to reducing the cost of monitoring. The difference in the time it takes to estimate the stability of the product when using different methods also helps manufacturers consider the appropriate evaluation method for their products.

Keywords: *Stability, shelf life, functional food, yogurt, frozen meat, Q10, Van't Hoff.*

1. INTRODUCTION

Shelf life is the manufacturer's commitment to the customer, which is a time limit where beyond that time, the goods are not allowed to circulate. According to law No. 55/2010/QH12 Food safety and Decree No. 43/2017/ND-CP on trademarks, some products are required to specify the shelf life such as food, food, food additives, cosmetics, medicinal herbs, animal feed, plant varieties, fertilizers,... on the product packaging. The period from the date of manufacture to the expiration date is called the shelf life on the label. The shelf life on the label indicates the length of time that consumers can expect the product to be safe and effective, the product reaches the required stability. There are currently many standard guidelines for assessing stability for pharmaceuticals regulated by organizations around the

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world such as ICH [1], WHO [2], Europe [3] and domestically according to Circular 32/2018/TT-BYT for pharmaceuticals and Circular 18/2019/TT-BYT for functional foods. For food, some methods have also been published to determine stability/shelf life such as: kinetic modeling, accelerated aging patterns on food products in general [4] or for some specific groups of subjects such as: cool products [5], frozen products [6], dried products [7], meat [8-10], grease [11], yogurt [12], ... Due to the differences in the nature of the sample background as well as the observed indicators, there is not a common method to apply to all food sample backgrounds. For each object or group of objects, it is necessary to survey and choose its own model and criteria.

Tropical monsoon climate conditions, hot and humid, rainy in Vietnam will greatly affect the conditions of food preservation, especially fresh products, products containing microorganisms. In fact, there are many food products that have suffered a rapid decline in quality during circulation, when the expiration date has not expired as announced on the label. Therefore, the study of processes that determine the shelf life of food is necessary to ensure product quality. This study was conducted to evaluate the stability of three subjects representing three different storage conditions: Fresh food with short shelf life in freezing conditions, food packaged with average shelf life in cold conditions, functional foods with long shelf life at normal conditions.

2. MATERIALS AND METHODS

2.1. Study sample

The sample included frozen pork, yogurt, vitamin-containing supplements.

2.2. Chemicals

Standard vitamin B1 (Thiamin.HCl) (Sigma, batch number LRAC2207; 99%), vitamin B2 standard (Riboflavin) (Sigma, batch number IRAC5854; 98.1%), standard vitamin B6 (Pyridoxin.HCl) (Sigma, batch number LRAC4191; 99.9%). HPLC grade solvents: CH_3CN, H_3PO_4, KH_2PO_4 (Merck).

2.3. Equipment

The HPLC high-performance liquid chromatography system (Shimadzu 20A) is equipped with PDA detector. The chromatography column was Sunfire C18 (250 mm × 4.6 mm; 5 µm). Climate cabinet (Memmert), temperature from 5°C to 70°C; humidity ranges from 10 to 90%. Refrigerator (PHCBI), temperature from -10°C to 60°C. Deep freezer (PHCBI), temperature from -35°C to -18°C. Other conventional auxiliary equipment of the laboratory.

2.4. Methods

2.4.1. Sampling method

Contact the production unit to collect the sample as soon as possible after the sample is produced and packaged with the number of samples ensuring uniformity and sufficient for the research process. Specifically: yogurt samples take 60 boxes, each box 100 g; frozen pork samples take 21 boxes, 200 g each; samples of nuggets supplemented with vitamin B1, vitamin B2, vitamin B6 take 17 boxes, each box 30 packs, each pack 3 g.

2.4.2. Sample storage conditions

- Frozen meat samples are stored according to the manufacturer's regulations (frozen at the freezer temperature: -20°C ± 2°C, humidity: 100%) use laboratory refrigerators that have been temperature calibrated and ensure temperature uniformity between the positions in the cabinet.

- Yogurt samples are stored according to the manufacturer's regulations (cold conditions at temperature: 4°C ± 2°C, humidity: > 80%.) using laboratory refrigerators that have been temperature calibrated and ensure temperature uniformity between the positions in the cabinet.

- Functional food samples stored in climate cabinets have been calibrated temperature and humidity, ensuring uniformity between positions in the cabinets. Cabinets are installed under rapid aging conditions: 35 ± 2°C, 45 ± 2°C, 55 ± 2°C and humidity: 70 ± 5%; Real-time tracking conditions of 25 ± 2°C and humidity of 70 ± 5%.

2.4.3. Sample collection time

The samples after collection are taken out to the first sample unit for a full analysis of the quality and safety indicators, ensuring that the prescribed requirements are met before being put into stability testing. The result is the value at the t_0. The time of further sampling depends on the nature of the sample background and the expected shelf life but will include the following times: 95% of the expected shelf life, 100% of the expected shelf life and 105% of the expected shelf life [4, 9].

Frozen meat samples with an expected shelf life of 12 months will be sampled at the initial time, the 3rd month, the 6th month, the 9th month, the 11.4th month, the 12th month and the 12.6th month.

Yogurt samples with an expected shelf life of 45 days will be sampled at the initial time, day 7, 14, 21, 28, 35, 42, 45, 47.

Functional food samples with an expected shelf life of 36 months will be sampled at the initial time and the 2^{nd,} 4th, 6th, 8th months with rapid aging conditions and every three months with real-time conditions. Due to the time constraints of the study, real-time monitoring was only carried out for up to 12 months.

2.4.4. Indicators and methods of analysis

With the goal of assessing the most affected indicators in the process of assessing stability, conduct an analysis of all indicators according to the standards of the product. Specifically, frozen meat samples according to TCVN 7047:2020, yogurt samples according to TCVN 7030:2016 and functional food samples as announced on the label. Some safety indicators such as heavy metals, parasites, antibiotics, hormones are only analyzed at the beginning and the end to confirm the quality of the product meets the standard requirements before and after conducting the study. The remaining indicators are fully evaluated in all samplings.

The analytical indicators in the sample backgrounds analyzed using the recommended method mentioned in TCVN 7047:2020 for frozen meat samples (including: Sensory, pH, hydrogen sulfide, ammonia, total aerobic microorganisms, *Coliforms, E. coli, S. aureus, Cl. Perfringens, Salmonella*, *Cysticercus bovis* parasites, Helminth parasites, Cadimi, Lead, Mercury, Dietylstylbestrol, Testosterol, Estadiol, Beta-agonist Group), TCVN 7030:2016 for yogurt samples (including: Total number of microorganisms forming strains (*Lactobacillus bulgaricus, Streptococcus thermophilus*), *Coliforms, E. coli, Salmonella, S. aureus, Salmonella*, Arsenic, Cadimi, Lead, Mercury) and vitamin B1, Vitamin B2, Vitamin B6 method for functional food samples using internal methods developed by the laboratory of the National Institute for Food Control has been recognized ISO 17025.

2.4.5. Data analysis

At each time of analysis, evaluate the quality and safety indicators in accordance with the current regulations. Frozen meat samples evaluated according to TCVN 7047:2020; yogurt sample evaluated according to TCVN 7030:2016; Functional food samples are evaluated on demand ≥ 80% of the value on the label.

The experiment was stopped when at least one target is not met and the shelf life would be estimated at that time or when the monitoring period expires according to the construction process. Assess statistically significant differences at the time of sampling compared to the original time according to the t-test formula:

- Where the variance is equal:

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Degrees of freedom: $\nu = n_1 + n_2 - 2$

Evaluate:

If the t-test > critical value that two different average values are statistically significant.

If the t-test < critical value that two different average values that are not statistically significant.

- Where the variance is not equal:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Degrees of freedom:

$$v = \frac{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

Evaluate:

If the t-test > critical value that two different average values are statistically significant.

If the t-test < critical value that two different average values that are not statistically significant.

2.4.6. Estimate the shelf life of the product

For real-time methods, the shelf life is calculated at the time just before the time when at least 01 target is not met.

For the accelerated aging method, estimate the shelf life through the Q10 formula and the Van't Hoff equation

Formula Q10:

$$t_s = t_0.Q_{10}^{\ n}$$

In which:

t_s: Shelf life under normal storage conditions.

t_0: Shelf life under heat acceleration conditions.

n: Heat acceleration temperature (°C) minus normal storage temperature (°C) divided by 10°C.

Van't Hoff equation:

$$t_{80}(t_2) = k_* t_{80}(t_1) + t_0$$

In which:

$t_{80}(t_2)$: Shelf life at storage temperature, t_2: storage temperature.

$t_{80}(t_1)$: Life at aging temperature, t_1: aging temperature.

K: Van't Hoff coefficient = $2^{\Delta t/10}$

Δt: Temperature difference = t_1 - t_2

t_0: Time from ex-factory date to experimental storage date

3. RESULTS AND DISCUSSIONS

3.1. Yogurt sample stability monitoring results

The results of the analysis of the targets required by TCVN 7030:2016 for yogurt background are shown in Table 1.

Table 1. *Yoghurt sample stability monitoring results*

No.	*Test*	*Sample collection time (date)*								
		0	*7*	*14*	*21*	*28*	*35*	*42*	*45*	*47*
1	Sensory	Good	Good	Good	Good	Good	Good	Good	Good	Partial layering (False)
2	Protein content, %	3.35 ± 0.02	3.36 ± 0.04	3.33 ± 0.02	3.34 ± 0.04	3.36 ± 0.04	3.34 ± 0.04	3.37 ± 0.02	3.36 ± 0.04	3,38 ± 0,02
	t-test	x	0.484	1.391	0.568	0.509	0.545	1.549	0.559	1.69
3	Fat content, %	3.11 ± 0.05	3.08 ± 0.04	3.09 ± 0.05	3.12 ± 0.02	3.12 ± 0.04	3.08 ± 0.04	3.12 ± 0.03	3.10 ± 0.04	3,03 ± 0,06
	t-test	x	1.208	0.769	0.502	0.429	1.249	0.453	0.416	2.586
4	Acid value, % according to lactic acid	1.04 ± 0.02	1.03 ± 0.01	1.05 ± 0.01	1.04 ± 0.02	1.04 ± 0.02	1.05 ± 0.02	1.05 ± 0.02	1.06 ± 0.03	1,07 ± 0,02
	t-test	x	1.095	1.732	0	0	1.142	1.142	2.191	2.631
5	Total number of microorganisms forming strains *(Lactobacillus bulgaricus, Streptococcus thermophilus)* CFU/g	7.51 ± 0.10 × 10^8	7.60 ± 0.77 × 10^8	7.53 ± 0.05 × 10^8	7.58 ± 0.12 × 10^8	7.54 ± 0.11 × 10^8	7.55 ± 0.11 × 10^8	7.56 ± 0.11 × 10^8	7.59 ± 0.11 × 10^8	7.54 ± 0.10 × 10^8
	t-test	x	1.723	0.412	1.771	0.476	0.838	0.936	1.532	0.691

The targets include other energy metals and microorganisms according to TCVN 7030:2016 are met as required at the time of origin and the time of end.

With the criteria for evaluating the sample sensory must be smooth and dense, so the product meets the requirements according to TCVN 7030:2016 at least 45 days from the time of packaging and does not meet the sensory criteria when monitored to the 47th day.

According to TCVN 7030:2016 protein, fat, acidity, the total number of microorganisms forming the prescribed strain ≥ 2.7%; ≤ 15 %; ≥ 0.6 %; ≥ 107 CFU/g; table t value = 2,228. Although the above targets are satisfactory from the beginning to 47 days when evaluated according to TCVN 7030:2016, when compared to the start time, the product has a different fat content and acidity from day 47th and the difference is statistically significant through the average value.

The acidity target in terms of lactic acid increased from 1.04 to 1.07% due to microorganisms forming lactic acid during storage, the total number of microorganisms formed without statistical difference until the end of the study cycle due to microorganisms being in the equilibrium phase and can begin to degrade when reduced from 7.59 × 10^8 CFU/g to 7.54 × 10^8 CFU/g in line with previous studies [6, 8, 14, 17].

Thus, the product reaches stability up to 45^{th} days after shipment. This result is consistent with the publication on the product label.

3.2. Frozen Meat Stability Monitoring Results

The test criteria and the results of monitoring the stability of the frozen meat sample were shown in Tables 2.

***Table 2**. Frozeen meat sample stability monitoring results*

No.	Test	Sample collection time (month)						
		0	3	6	9	11,4	12	12,6
1	Sensory	Good	Good	Good	Good	Good	Good (the smell after boiling is no longer as fragrant as it was originally)	Good (the smell after boiling is no longer as fragrant as it was originally)
2	pH	5.92 ± 0.053	5.94 ± 0.052	5.94 ± 0.057	5.96 ± 0.054	5.97 ± 0.061	5.98 ± 0.077	5.98 ± 0.047
	t-test	x	0.659	0.632	1.300	1.517	1.576	2.083
3	Amoniac content, mg/100g	20.67 ± 0.33	20.63 ± 0.36	20.63 ± 0.31	21.02 ± 0.31	21.48 ± 0.38	21.35 ± 0.24	21.40 ± 0,18
	t-test	x	0.199	0.216	1.876	3.95	4.041	4.730
4	Total aerobic microorganisms, CFU/g	3.52 ± 0.066 × 10^3	3.65 ± 0.17 × 10^3	3.72 ± 0.32 × 10^3	3.65 ± 0.31 × 10^3	3.69 ± 0.31 × 10^3	3.76 ± 0.32 × 10^3	3.80 ± 0,27 × 10^3
	t-test	x	1.764	2.060	0.887	1.173	1.679	1.900

The targets including heavy metals and other microorganisms according to TCVN 7047:2020 are met as required at the initial time and the time of end.

The sample assessed by the sensory council after boiling is no longer as fragrant as it was originally, the results are verified in parallel with a similar frozen meat sample that has just been shipped. However, other sensory indicators are still satisfactory, so to accurately assess the difference in smell requires quantitative studies using tool devices.

The pH, ammonia, total aerobic microorganisms meet the requirements of TCVN 7047:2020 (the limit value of the prescribed targets is 5.6 - 6.2; ≤ 35 mg/100g; ≤ 10^5 CFU/g. However, the ammonia content from 11.4 months onwards has a statistically significant difference when compared to the time of t_0

The product was satisfactory under TCVN 7047:2020 from the ex-factory date until the end of the experiment (12.6 months) and the stability of the meat sample in the study was longer when compared to previously published studies [9-10]. PH targets, ammonia content, total aerobic microorganisms tend to increase during storage in line with previously published studies [9-10]

The product achieves stability for 12.6 months in line with the manufacturer's 12 months shelf-life announcement. However, the actual shelf life of the product can last more than 12.6 months.

3.3. Results of functional food stability monitoring

Test indicators and results of monitoring the stability of functional food samples were shown in Tables 3 and Table 4.

Table 3. *Results of monitoring the stability of functional food samples at accelerated aging conditions*

Temperature	***Test***	***Content (mg/3g)***					***Product announcement***
		t_0	***2nd month***	***4th month***	***6th month***	***8th month***	
35 ± 2°C	Vitamin B1	1.05	1.04	1.00	0.99	0.98	1 mg/3g ± 0.2 mg/3g
		1.03	1.04	1.02	0.98	0.96	
		1.06	1.04	0.99	0.96	0.96	
45 ± 2°C; 70 ± 5%		1.06	1.01	0.97	0.90	0.85	
		1.05	1.01	0.94	0.89	0.86	
		1.01	0.97	0.98	0.92	0.85	
55 ± 2°C		1.03	0.98	0.90	0.78	0.76	
		1.01	0.98	0.90	0.79	0.76	
		1.06	0.99	0.86	0.79	0.72	
35 ± 2°C	Vitamin B2	0.53	0.52	0.50	0.50	0.48	0.5 mg/3g ± 0.1 mg/3g
		0.52	0.52	0.50	0.50	0.49	
		0.52	0.50	0.51	0.49	0.48	
45 ± 2°C; 70 ± 5%		0.53	0.49	0.47	0.45	0.44	
		0.51	0.50	0.47	0.46	0.45	
		0.53	0.49	0.47	0.45	0.43	
55 ± 2°C		0.51	0.48	0.46	0.40	0.36	
		0.50	0.48	0.46	0.39	0.38	
		0.52	0.50	0.43	0.40	0.37	
35 ± 2°C	Vitamin B6	1.04	1.00	0.99	1.00	0.94	1 mg/3g ± 0.2 mg/3g
		1.06	1.01	0.99	0.98	0.95	
		1.06	1.00	0.98	0.99	0.95	
45 ± 2°C; 70 ± 5%		1.02	0.98	0.93	0.91	0.89	
		1.02	1.02	0.93	0.94	0.85	
		1.05	0.98	0.98	0.92	0.87	
55 ± 2°C		1.05	0.96	0.87	0.74	0.75	
		1.05	0.98	0.89	0.77	0.73	
		1.02	0.93	0.92	0.80	0.70	

Table 4. *Results of monitoring the stability of functional food samples at real-time monitoring conditions*

Temperature	***Test***	***Content (mg/3g)***					***Product announcement***
		t_0	***3rd month***	***6th month***	***9th month***	***12th month***	
25 ± 2°C	Vitamin B1	1.05	1.03	1.02	0.99	0.97	1 mg/3g ± 0.2 mg/3g
		1.05	1.05	0.98	1.01	0.96	
		1.05	1.03	0.98	0.98	0.98	
25 ± 2°C	Vitamin B2	0.53	0.53	0.5	0.5	0.5	0.5 mg/3g ± 0.1 mg/3g
		0.51	0.51	0.5	0.48	0.48	
		0.53	0.51	0.5	0.49	0.49	
25 ± 2°C	Vitamin B6	1	1.04	1.03	0.96	0.98	1 mg/3g ± 0.2 mg/3g
		1.03	1.01	0.98	0.99	0.97	
		1.05	1.02	0.99	0.97	0.96	

From the parameters obtained from Table 3 and Table 4 that create a linear regression equation between the concentrations of the analyzed substance over time, the results were shown in Table 5.

Table 5. *Linear regression standard road equation between concentrations over time*

Test	***Conditions***	***Temperature, humidity***	***Equation regression line***	R^2
Vitamin B1	Real-time conditions	25 ± 2°C	y = -0.0068x + 1.0493	0.9275
	Rapid aging conditions	35 ± 2°C	y = -0.0124x + 1.0587	0.9655
		45 ± 2°C; 70 ± 5%	y = -0.0258x + 1.0595	0.9901
		55 ± 2°C	y = -0.0425x + 1.0658	0.9800
Vitamin B2	Real-time conditions	25 ± 2°C	y = -0.0031x + 0.5227	0.9250
	Rapid aging conditions	35 ± 2°C	y = -0.0053x + 0.5263	0.9797
		45 ± 2°C; 70 ± 5%	y = -0.0112x + 0.5229	0.9310
		55 ± 2°C	y = -0.0205x + 0.5288	0.9910
Vitamin B6	Real-time conditions	25 ± 2°C	y = -0.0054x + 1.0313	0.9560
	Rapid aging conditions	35 ± 2°C	y = -0.0121x + 1.0467	0.8106
		45 ± 2°C; 70 ± 5%	y = -0.0214x + 1.0426	0.9797
		55 ± 2°C	y = -0.0446x + 1.0648	0.9719

Based on the standard line obtained above the estimate of when the vitamins were 80% compared to the product announcement, thereby estimating the shelf life of the product through the Van't Hoff formula and the Q10 formula, the results were shown in Table 6.

Table 6. *Estimated shelf life according to Van't Hoff formula and Q10 formula*

Test	*Temp. (°C)*	*When the B vitamin content is 80% (month)*	*Shelf life according to van't Hoff formula (month)*	*Comparative temperature range according to formula Q10*	*Q10*	*Average Q10 coefficient*	*Shelf life according to Q10 formula (month)*
Vitamin B1	25	36.8	36.8				
	35	20.9	41.7	45/35	2.07		37.2
	45	10.1	40.3	55/35	1.67	**1.78**	32.0
	55	6.25	50	55/45	1.61		35.5
Vitamin B2	25	39.4	39.4				
	35	23.8	47.6	45/35	2.16		46.1
	45	11.0	44.0	55/35	1.90	**1.94**	41.3
	55	6.28	50.2	55/45	1.75		45.6
Vitamin B6	25	42.5	42.5				
	35	20.4	40.9	45/35	1.80		37.0
	45	11.3	45.3	55/35	1.72	**1.81**	37.2
	55	5.93	47.5	55/45	1.91		35.3

In real-time conditions in Table 4, the monitoring results showed that there was still a slight decrease in the content of B vitamins compared to the specific initial: Vitamin B1 decreased by 7 -9%, vitamin B2 decreased by 6 - 8%, vitamin B6 decreased by 2 - 9% in 12 months of stability monitoring. After a 12-month follow-up period, the product still meets the requirements of the product. Assuming the product gradually decreases linearly over time based on the standard sugar formula, then at 36.8 months the vitamin B1 content is only 80% compared to the announced, 39.4 months for vitamin B2 and 42.5 months for vitamin B6.

At the rapid aging conditions in Table 3, all three indicators of B vitamins tend to decrease with the time of storage and the rate of decrease is proportional to the increase in temperature. In which, vitamin B2 tends to lose the most during rapid aging then to vitamin B6 and vitamin B1.

At a temperature of 35 ± 2°C, 45 ± 2°C the vitamins B targets still have a content of over 80% compared to the label for the end of the 8th month.

At a temperature of 55 ± 2°C the vitamins B targets were 80% smaller than those announced on the label when evaluating the results at the 6th month.

Based on the results of the shelf life assessment based on the Q10 coefficient compared to the results of the assessment according to the Van't Hoff formula, the results of the shelf life assessment based on the Q10 coefficient showed the results of the assessment at three different temperature levels are more similar when evaluated according to the Van't Hoff formula. This difference is due to the Van't Hoff formula fixing the variable coefficient according to temperature of 2, while using the Q10 coefficient can accurately calculate the variable coefficient according to the temperature of each product object. From there, using the Q10 coefficient can give more accurate estimation results for each model background to assess stability.

However, economically, using the Van't Hoff formula could reduce testing costs by simply evaluating the aging product at one specified temperature, whereas to use the Q10 coefficient it is necessary to analyze the sample at at least two specified temperatures. Therefore, depending on the nature of the sample background, manufacturers can choose different evaluation methods: it is possible to choose the Van't Hoff formula when the sample background is stable and the Q10 formula is selected when the sample background is less stable.

As such, the estimated shelf life of functional foods was 36.8 months longer than the manufacturer's announcement.

4. CONCLUSION

The study applied real-time methods and accelerated aging methods to determine the stability of three food and functional food subjects representing different storage conditions. The results of the study indicate that the indicators that were greatly altered during the evaluation process include: yogurt (sensory, lactic acid, the total number of microorganisms that form the strain); frozen meat (pH, ammoniac, total aerobic microorganisms); functional foods (vitamins B). This wasv the basis for selecting quotas for further studies to reduce assessment costs. In addition, the study also compared the results of estimated shelf life according to the Van't Hoff formula and the Q10 formula as the basis for selecting the appropriate evaluation method for each sample background.

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Kết quả nghiên cứu độ ổn định của một số sản phẩm thực phẩm và thực phẩm chức năng

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Tóm tắt

Nghiên cứu này ứng dụng phương pháp lão hóa cấp tốc và phương pháp điều kiện thực để đánh giá độ ổn định của thịt đông lạnh, sữa chua và thực phẩm chức năng. Phương pháp điều kiện thực được áp dụng cho thịt đông lạnh và sữa chua với các yếu tố lần lượt là: nhiệt độ: -20°C ± 2°C, độ ẩm: 100% cho thịt đông lạnh và nhiệt độ: 4°C ± 2°C, độ ẩm: > 80% cho sữa chua. Phương pháp lão hóa cấp tốc được áp dụng cho thực phẩm chức năng ở điều kiện: 35 ± 2°C, 45± 2°C, 55 ± 2°C và độ ẩm: 70 ± 5% kết hợp đánh giá song song với theo dõi thời gian thực tại 25 ± 2°C và độ ẩm 70 ± 5%. Kết quả thu được cho thấy: mẫu sữa chua đạt độ ổn định đến ngày thứ 45 và không đạt từ ngày thứ 47 do bị phân lớp và có lắng cặn ở dưới đáy hộp. Mẫu thịt đông lạnh vẫn đạt độ ổn định khi theo dõi đến tháng thứ 12,6 với tất cả các chỉ tiêu. Mẫu thực phẩm chức năng được ước đoán đạt độ ổn định đến 40,3 tháng khi sử dụng công thức Van't Hoff, 32,0 tháng khi sử dụng hệ số Q10 và 36,8 tháng khi theo dõi ở điều kiện thực. Kết quả của nghiên cứu chỉ ra chỉ tiêu kém ổn định trên mỗi nền mẫu là cơ sở để lựa chọn chỉ tiêu đánh giá cho những nghiên cứu tiếp theo góp phần giảm chi phí theo dõi. Sự khác nhau về thời gian ước đoán độ ổn định của sản phẩm khi sử dụng các phương pháp khác nhau cũng giúp các nhà sản xuất cân nhắc phương pháp đánh giá phù hợp cho các sản phẩm của mình.

Từ khóa: *Độ ổn định, shelf life, TPCN, sữa chua, thịt đông lạnh, Q10, Van't Hoff.*