DEGRADATION KINETICS OF VITAMIN C IN CHILI STORED AT DIFFERENT TEMPERATURES

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ABSTRACT

The kinetic degradation of vitamin C in chili stored at two different temperatures (4°C and 25°C) for 9 days with a 3 days interval was the main focus of the current investigation and for this purpose, three stages (immature, mature, and ripped) chilies were collected. Maturity stages significantly influenced vitamin C content, chemical composition, total phenolic content (TPC), total flavonoid content (TFC), and antioxidant content. The degradation kinetics, mainly first-order, varied across samples and temperatures, except for immature (4°C) and mature 25°C) stages, where zero-order kinetics were observed. The Page model revealed that mature chili at 4°C exhibited the highest significance. Overall, fresh chili should be consumed whenever feasible because all forms of chili start to decay extremely quickly after a certain number of days. Therefore, consumption of fresh chili or stored for a short period is safer than eating chili that has been preserved for a longer time.

Keywords: *Chili, vitamin C, Page model, antioxidant, zero-order kinetics, first-order kinetics.*

1. INTRODUCTION

Capsicum frutescenes L. is a bushy plant with a chili pod that is commonly used as a spice. In several nations across the world, it is a significant condiment and high-value crop. In the kitchen, chilies are almost a need for regular cooking. The primary use of chilies in food is to provide flavor, color, and scent [1]. One of Bangladesh's most important and marketable crops is chili. It is almost cultivated everywhere in the country. Around the world, there are more than 400 different types of chilies. Other names for it include bell pepper, sweet pepper, hot pepper, etc. According to the USDA Nutrient Database, it has significant levels of vitamin C, small amounts of carotene, vitamin B, vitamin B6, potassium, magnesium, and iron. One of the finest-producing countries is Bangladesh, however, there is not enough industry to preserve this fruit [2]. Most houses in Bangladesh always keep a stack of fiery, fresh green chilies on hand and use 2 them to spice the majority of curries and dry meals. In the early stages of making the meal, it is often gently cooked in oil while being peppered with chilies [3]. In general, when most kinds of chili fruit begin to mature, the concentration of chlorophyll declines, and the level of carotenoids rises as the chloroplasts are transformed into chromoplasts. Both genetics and environment influence these biological processes [4].

Recent studies at the Cancer Research Institute in Adyar, Madras, found that green chilies inhibit cancer because they naturally contain the enzyme asparaginase, which is only useful when taken in pure or isolated form. According to Ayurvedic research, chilies increase blood production, aid in the production of bile, and remove worms from the intestines. They have the added benefit of serving as a healthy vitamin supplement when eaten fresh with salads. Nevertheless, when administered specifically for atonic dyspepsia, it has a tonic and carminative effect [5].

While the pungent principle of capsaicin is used to make balms, the color extracts (carotenoid pigment) find use as an additive in food, poultry, and prawn feed industries. Chili is used in the food and beverage industries in the form of oleoresin, which allows for better distribution of color and flavor in food. Ginger beer and other beverages are made with the aid of chili extracts. To make sauces, pickles, ketchup, and other fast meals, the food production sector, and the confectionary employ chili powder [6].

There is hardly much literature on how to use green chili and its products. Fresh green chili's lovely perfume cannot be compared to that of dried chili. Thus, there is an opportunity to investigate chili processing techniques that can preserve the delicate fresh flavor. Based on the information so far accumulated, the present study has been undertaken with the following major objectives:

1. To observe the proximate compositional analysis of chili at different maturity stages;
2. To assess the kinetic degradation of vitamin C in chili during storage.

2. MATERIALS AND METHODS

2.1 Collections of samples and raw materials

Three types of chilies namely immature, mature, and ripe were used in this study. They were collected from commercial farmland located in a village in Mymensingh Sadar. Maturity stages were identified based on their fruiting to harvesting time as per the farmer's experience. After collection, chilies were transported right away to the lab for further experiments. Samples were very carefully washed with distilled water before being dried on clean, soft tissue paper. After that packaging of green chilies was done into a zipper bag and then stored at refrigerated conditions at 4°C and 25°C to determine the degradation of vitamin C.

2.2 Proximate chemical analysis of chili powder

Stored chilies were cut into small pieces and then dried by a mechanical drying (chamber dryer) and dried chilies were then converted into powder by using a blender. For all stages of chilies, moisture, protein, fat, ash content were identified by Ranganna [7] and vitamin-C (ascorbic acid) by Srivastava [8].

$$\text{Ascorbic acid (mg /100gm)} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Volume of filtrate taken} \times \text{weight/volume of sample taken}} \times 100 \quad \text{......(1)}$$

2.3 Determination of total phenolic content (TPC) of chili powder

Using the Folin-Ciocalteu phenol reagent technique, the total phenolic content was calculated as gallic acid (GA) equivalents per gram of dried plant extract [9].

2.4 Determination of total flavonoid content (TFC) of chili powder

Using the colorimetric technique for aluminum chloride, the total flavonoid concentration was calculated [10].

2.5 Determination of total antioxidant of chili powder

Total antioxidant values were evaluated by Prieto [11].

2.6 Kinetics modeling and fitting

Kinetic parameters were evaluated according to Burdurlu [12],

$$\ln(C) = \ln(C_0) - kt \quad \text{.....................................(2)}$$

Where, k = rate constant, C_0 = initial concentration of vitamin C in the sample, and C = concentration of vitamin C in the sample at time t.

After calculating the concentration of vitamin C data from the stored chili samples, they were entered into the Excel sheet. Experimental and predicted data were fitted to the Page equation and model parameters were calculated using Excel solver.

2.7 Statistical analyses

The results of experiments were presented as the means ± standard deviation. Data were analyzed by using the SPSS, a statistical computer program, and significant differences of means were determined using Duncan's multiple-range test.

3 RESULTS AND DISCUSSIONS

3.1 Composition of fresh chili

The proximate compositions of the fresh chilies of all stages were analyzed for moisture, protein, fat, and ash percentage and presented in Table 1.

Table 1. Proximate parameters of chilies at different maturation stages

Properties	Immature	Mature	Ripe
Moisture (%)	84.95±0.41	79.09±0.37	67.10±0.75
Ash (%)	1.21±0.04	2.20±0.02	1.05±0.04
Protein (%)	4.17±0.06	2.58±0.04	2.31±0.04
Fat (%)	1.10±0.03	1.51±0.02	1.44±0.03

The moisture levels of the control, immature, mature, and ripe were all between 67.10% and 84.95%, with immature having the lowest moisture content and ripen having the highest. The findings were roughly in line with those made public by Choudhury [13]. The ash level of fresh chilies during the immature, mature, and ripening stages ranged from 1.05 to 2.20% per 100gm, with mature chili having the lowest and immature chili having the highest values. The outcomes were generally comparable to those that Raina [14] and Teotia [15] reported. Obtained ash level of green chili powder ranging from 4.53% to 7.39%. The differences in ash contents across the samples under examination may be the result of various treatments, preparations, and procedures. Then it could remark that the green chili's stem contains more ash than green chili powder. The fat level of mature chili powder was greater than that of control immature, mature, and ripe chili powder, which ranged in fat content from 1.10 to 1.51%. (Table 1). The findings were roughly in line with those made public by Choudhury [13]. The protein level of immature, mature, and ripe chili ranged from 2.31 to 4.17%, with the control having the lowest protein content and the immature chili having the greatest protein amount due to its greater fat content (Table 1). The findings were essentially in line with those made public by Choudhury [13], who noted that there was a protein of 2.9% in dried chili per 100g. Differences in species, maturation, treatments, preparation, and drying techniques may be to blame for the diversity in protein levels between the samples under investigation.

3.2 Antioxidant parameters

Antioxidant parameters like total phenolic content (TPC), total flavonoid contents (TFC) and total antioxidant content are presented in Table 2.

Table 2. Functional parameters of chilies at different maturation stages

Properties	Immature	Mature	Ripe
Total anti-oxidant (%)	2.41±0.04	2.43±0.01	1.82±0.02
TFC (%)	0.61±0.03	0.63±0.01	0.63±0.02
TPC (%)	1.97±0.06	1.97±0.03	1.95±0.03

Anti-oxidant content in immature and mature chili samples varied slightly but showed noticeable variation in ripe chili samples, TFC values in chili samples varied insignificantly but the variation in TPC level was not much.

3.3 Kinetics modeling of Vitamin C

Kinetic parameters for the studied samples were calculated according to the Page model and was found to be different for different samples at different temperatures (25°C and 4°C). All the samples at all the storage temperatures showed first-order kinetics, except immature chili at 4°C and mature one at 25°C which indicated zero-order kinetics.

The statistical analysis unmistakably showed that vitamin C levels in chili samples maintained at temperatures of 25°C and 4°C were strongly associated with storage duration and condition in all the samples.

Table 3. Regression and kinetics values for the studied samples

Sample type	Storage condition	Page model	
		K	**R^2**
Immature chili	25°C	-4.17	0.93
Mature chili	4°C	-3.9	0.97
Ripe chili	25°C	-4.13	0.90
	4°C	-3.7	0.88

The statistical model developed was significant for each sample of chili, with ripe chili having an R^2 of 0.88% and mature chili having an R^2 of 0.97%. The Page model demonstrated statistical significance, with mature chili at 4°C showing the most statistical significance (R^2 = 0.97%) (Table 3).

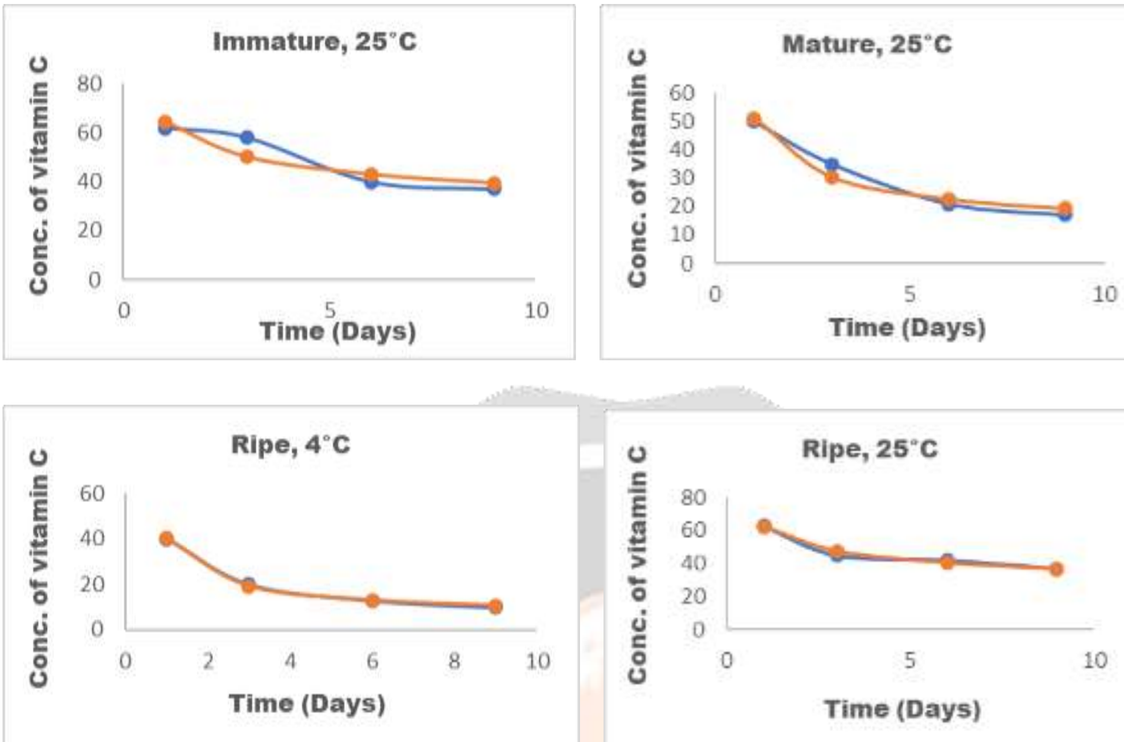

Fig-1: Vitamin C concentrations at different temperatures and storage conditions by Page method of studied samples

The Page model was used to calculate concentrations and produce experimental and predicted curves. All vitamin C concentration values indicated that the regression model's anticipated vitamin C levels and the experimental data for the various storage periods agreed well. By utilizing linear regression analysis to determine the mean relative percentage deviations, the goodness of fit was determined (Figure 2).

4. CONCLUSIONS

Mature chili holds vitamin C content for more time than the immature and ripe types. Regarding vitamin C content mature chili is the best as per this study. As after some days vitamin C content in all chili samples starts to degrade very rapidly, fresh chili should be consumed if it is possible. Hence, fresh chili consumption is more advantageous than stored chili from a nutritional point of view. In conclusion, further research is recommended to explore new dimensions of vitamin C degradation and other chemicals in chili stored at different temperatures.

5. ACKNOWLEDGMENT

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