Shelf life prediction of carica jam using accelerated method

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Abstract. Carica fruit (*Carica pusbescens, Lenne* & K. Koch) is rich in vitamin C, potassium, antioxidant, and dietary fiber. It could be used as main ingredient in fruit jam production. The jam formula consisting of carica fruit, pectin, gelatin, and sugar. The objectives of this study were to determine the shelf life of carica jam. The packaging used in this study were glass jar and PET jar. The products were stored at 35, 45, and 55ºC; and analyzed for its chemical and sensory characteristics at every 5 d for 20 d. The shelf life examined by the acceleration method using the Arrhenius equation with spread ability as the critical parameter. Results of the study showed that shelf-life of products packed with glass jar foil at room temperature (25ºC) was 1 year and 2 months and at cold temperature (8ºC) was 1 year 7 months; meanwhile, products packed in PET jar at room temperature (25ºC) was 6 months and at cold temperatures (8ºC) was 7 months.

Keyword : *Carica pubescens*, Linne & Koch., jam, chayote, shelf life

INTRODUCTION

Carica fruit is a geographical indication product from the highland region of Dieng, Central Java, Indonesia. It rich in Vit C, K, flavonoid, antioxidant, dietary fiber. It can only be consumed after processing. One of the processed carica is cocktails which is made from unripe fruit. The use of over-ripe fruit and byproduct from cocktails processing (pulp) has not been carried out. It have a strong flavor, soft texture, and become taint quickly when stored. A mixture of over-ripe carica fruit and its pulp can be used in jam production. The substitution of carica jam with chayote can reduce production costs. Chayote is rich in pectin and tasteless . Its suitable to be used as a substitute of carica fruit in jam production. Formula product consisting of sugar 28.46%, carica puree 33.34%, carica pulp 14.31%, and chayote puree 23.82%. It has sensory score (range 1-9) i.e. overall acceptibility 6.58 (rather like to like), spread ability 6.90 (easy to spread), taste 6.70 (rather like to like), adhesiveness 6.64 (rather sticky), and 6.38 (rather chewy) and consist 52.13% wb water, 1.20% db ash, 1.73% db protein, 1.08% db fat, 43.86% db carbohydrate by different, 191.76 Kcal / 100 g energy, 15.76% db dietary fiber, 31.52 mg / 100g vitamin C, color brightness intensity (L) 30.79, green color intensity (a) -0.45, yellow color intensity (b) 12.47, respectively.

To extend shelf life and facilitate transportation and distribution, products were packaged with several package alternatives, such as glass jar and PET jar. Shelf life needs to be determined to ensure product quality and safety for consumers. ASLT can predict the shelf life of a product quickly. Every 10oC increase in temperature, the rate of deterioration will be faster (twice). Spread ability used as critical parameter to determine shelf life.

Product shelf life is the time interval between production and consumption, where the product still has good quality, seen from its nutritional and sensory properties and and safety [6], [7]. Shelf life needs to be determined to ensure product quality and safety for consumers [8]. The accelerated shelf life testing with Arrhenius model can predict the product shelf life quickly [9]. This method has been widely used to examine product shelf life, such as instant coffee [10]. The concept used was Q10, where every 10^{o}C increase in temperature, the rate of deterioration will be faster. This principle has been used to determine shelf life of salacca fruit [11]. The quality testing during storage was carried out by medium shelf life principle, where products were tested every 5 days for 20 days [12]. Product was stored at a temperature higher

than room temperature to accelerate its deterioration [13]. The shelf life was determined using water content as critical parameter, because the product was hygroscopic, easily absorbs water from the environment. It easy to form agglomerates when stored. This properties was similar to instant coffee [10]. In addition, from previous research, it was proven that water content produced the highest R^2 value compared to other variables.

The objective of this research was to predict the shelf life of carica jam stored in glass jar and PET jar using the acceleration method and the Arrhenius model

MATERIALS AND METHODS

Materials

Carica fruit was obtained from Wonosobo district and other ingredient from Purwokerto district. Other ingredients (sugar, glass and PET jar, andother) were obtained from a local market in Purwokerto central Java.

Methods

The stages of this research were: 1) preparing materials, tools and other instruments; 2) making products with the optimum formula (results from previous research); 3) packing the product in glass jar and PET bottle; 4) storing the product in an incubator with a temperature of 35, 45, and 55oC; 5) testing water content of product at storage for 5, 10, 15, and 20 days by Gravimetric method [14].; 6) analyze and process data : determine the reaction order kinetics and Arrhenius equation; 7) determine the shelf life prediction of carica jam

Carica jam production

The procedure of making carica jam showed in Figure 1.

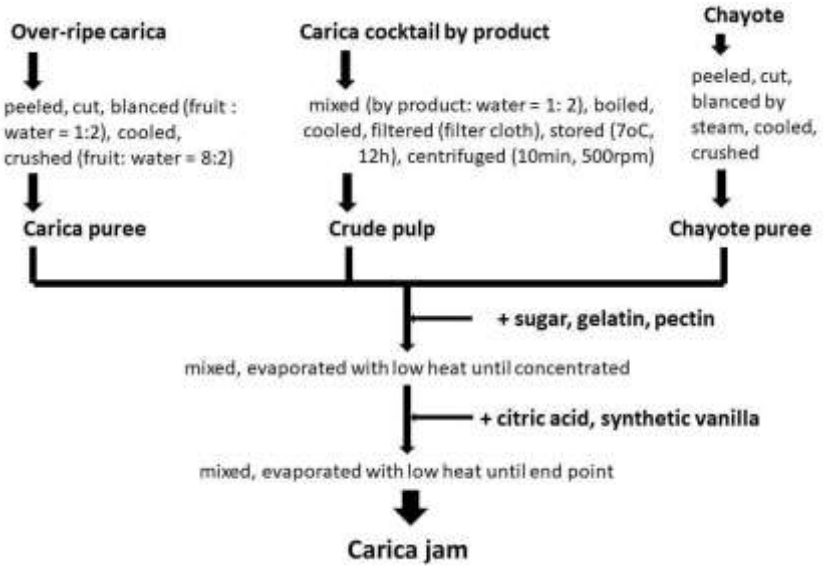

Figure 1. The procedure of carica jam production

Shelf Life Prediction Test Using Arrhenius Model

The spread ability of carica jam was plotted against time and three equations for different product storage temperatures, Y = bx + a will obtained , where "x" is the storage time (day), "Y" represents the characteristic value of carica jam, "a" is the initial characteristic value of carica jam, and "b" is the rate of characteristic change (slope). The quality decrease rate (*k)* obtained from every linear regression equation. Then, the ln *k* value was plotted with 1/T (K-1), and the intercept and slope value of the linear regression equation, ln k = ln $k0$ - (E / R) (1 / T) was obtained. The Arrhenius equation was calculated after activation energy characteristic of carica jam and constant value "*k0"* was obtained. It was calculated by this formula: $k = ko.e^{-E/RT}$ (1), where : k = quality degradation constant, ko = constant (independent of temperature), E = activation energy, T = absolute temperature (K), R = gas constant (1.986 cal / mol K). The rate of reaction (k) from the changes characteristic of carica jam at a pre-determined temperature (T) can be calculated by Arrhenius equation. The determination of shelf life of carica jam was done by spread ability as critical parameter because it has highest correlation coefficient (R2) compared to other parameter. Furthermore, " *k"* value obtained was entered into order equation of reaction: At = Ao + kt (2), where : Ao = A value at the beginning of shelf life, At = A value at the end of shelf life; t = shelf life; k = quality degradation constant. From this stage, the prediction of shelf life of carica jam for each specified temperature will be obtained [13].

RESULT AND DISCUSSION

The profile of spread abiliy of carica jam showed in Figure 2.

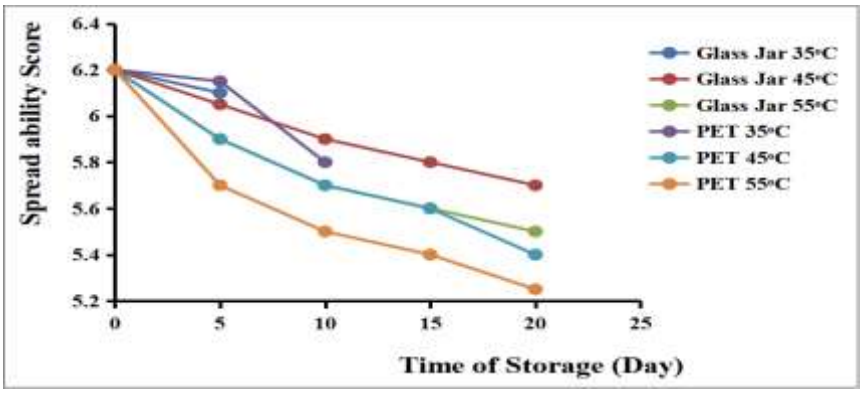

Figure 2. The profile of spread abiliy of carica jam

The results showed that the spread ability score decrease with the length of storage time and the higher in storage temperature. The decrease in the spread ability score during storage for products packed in PET jar was higher than those in glass jar. At 35^{o}C storage for 10 and 15 days, the products in the glass jar and PET jar had mold, so that the observation of the variables was stopped. Molds are mesophilic. They can grow at temperature with in the range 10-35^{o}C

Table 1. Order kinetics of carica jam in different packaging

Packaging	Temp.	Zero Order			First Order		
	(˚C)	Slope (k)	Intercept	R2	Slope (k)	Intercept	R2
Glass jar	35	-0.020	6.20	1	-0.003	1.824	1
	45	-0.025	6.18	0.988	-0.004	1.821	0.991
	55	-0.034	6.14	0.938	-0.005	1.811	0.946
PET Jar	35	-0.040	6.25	0.842	0.006	1.833	0.839
	45	-0.038	6.14	0.970	0.006	1.815	0.975
	55	-0.044	6.05	0.893	0.007	1.805	0.907

The determination of kinetic order reaction is a way to predict quality degradation. The zero order reaction indicate a constant rate of damage. It was detected by plotting water content as the y-axis and storage time as the x-axis. The first order reaction indicates the logarithmic or exponential rate of damage. It was detected by plotting the ln value of water content as the y-axis and storage time as the x-axis. The choice of kinetic order reaction was based on the linear regression equation from zero-order and first order reaction.

The kinetic order reaction used is the one with high R^2 value [18]. The higher value of the determination coefficient show higher accuration of data. The results showed that the average value of R^2 of products stored in glass jar and PET jar from the first order reaction was higher than zero order. This shows that the increase on spread abiliy of carica jam was exponential. The slope value states the relationship between spread ability and storage time.

Based on the value of the highest correlation coefficient (R2). the reaction order kinetics selected based on the linear equation at the same temperature is the first order reactions. The determination of order kinetics showed in Table 1 and Figure 3.

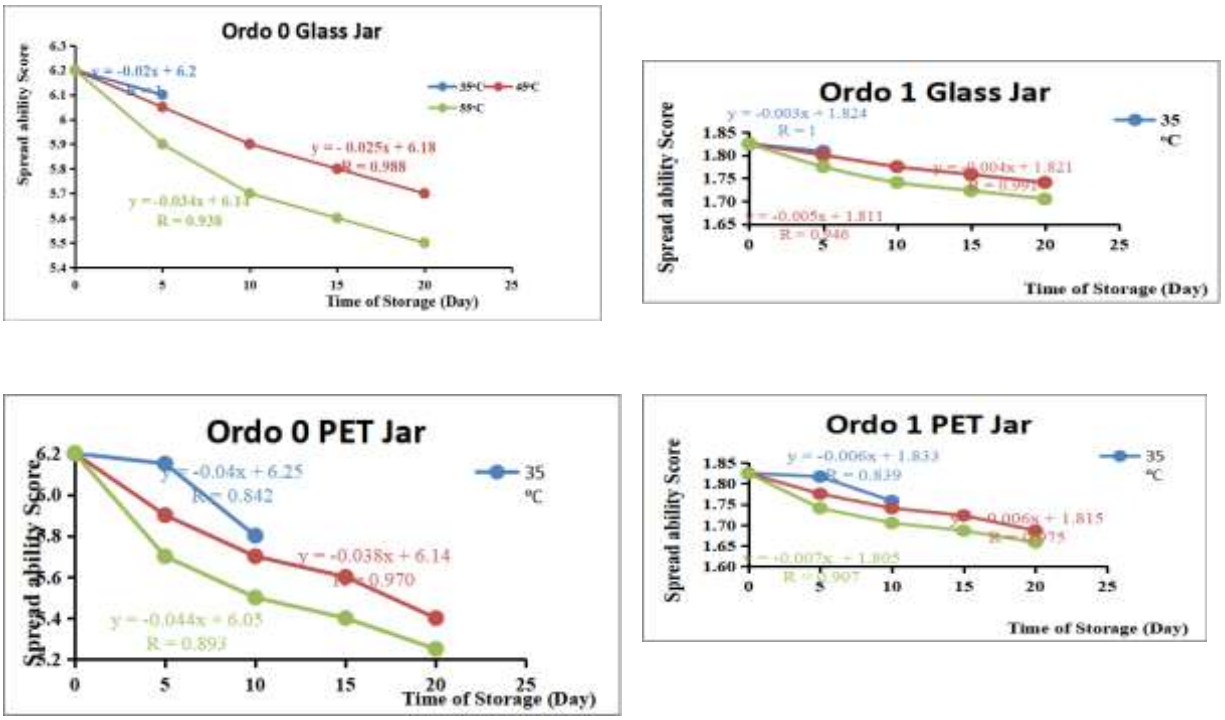

Figure 3. Ordo kinetics reaction

Based on the Arrhenius approach, the changes in product quality were strongly influenced by temperature. The Arrhenius equation is the relationship between the value of ln (natural log) k from the first order regression equation and the value 1 / T in ˚K units. The Arrhenius equation was obtained by plotting the value of ln k as the "y" axis and 1 / T as the "x" axis. The resulting Arrhenius equation is a constant value of deterioration (K). The Arrhenius equation and K value determination showed in Table 2 dan Table 3. The curve of Arrhenius aquation showed in Figure 4.

Table 2. Arrhenius equation determination

Packaging	T	K	ln k	T (˚K)	1/T	Linier equation	Arrhenius equation
	(˚C)				(˚K)	ln K vs 1/T	ln K = ln K0 – Ea/R
Glass jar	35	0.0030	-5.79	308	0.0032	Y =	ln K =
						-2582x + 2.584	2.584 + 2582x
	45	0.0039	-5.53	318	0.0031		
	55	0.0050	-5.28	328	0.0030	R2 = 0.99	
PET jar	35	0.0058	-5.14	308	0.0032	Y =	ln K =
						-770.2x + 2.640	2.640 + 770.2x
	45	0.0063	-5.06	318	0.0031		
	55	0.0068	-4.98	328	0.0030	R2 = 0.99	

Table 3. K value determination

Packaging	Temperature (˚C)	ln K	K
Glass jar	35	-5.79	0.0030
	45	-5.53	0.0039
	55	-5.28	0.0050
PET jar	35	-5.14	0.0058
	45	-5.05	0.0063
	55	-4.98	0.0068

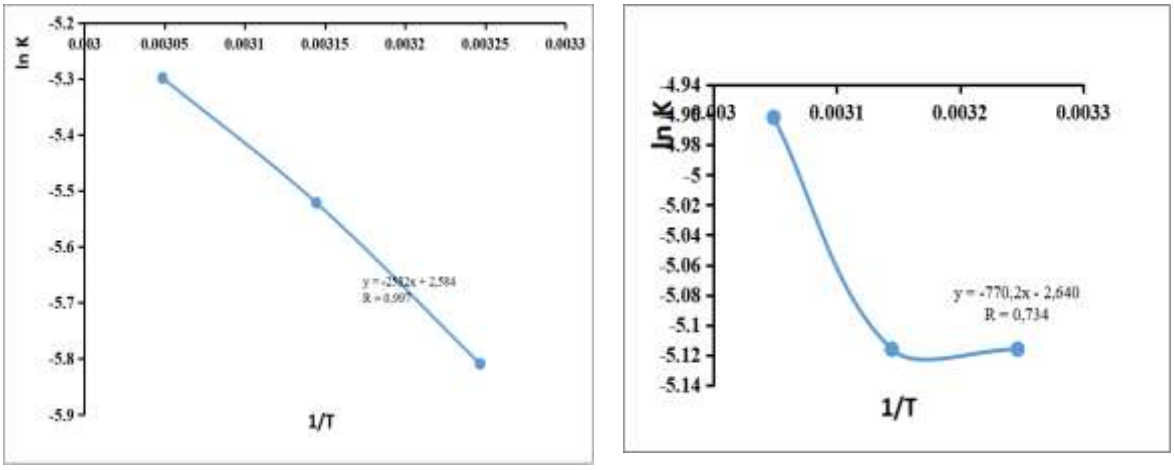

Figure 4. The curve of Arrhenius Equation

Based on Figure 5 and Table 4, it show that the shelf-life prediction of carica jam packed with glass jar at room temperature (25oC) was 1 year and 2 months and at cold temperature (8oC) was 1 year 7 months; meanwhile, products packed in PET jar at room temperature (25oC) was 6 months and at cold temperatures (8oC) was 7 months.

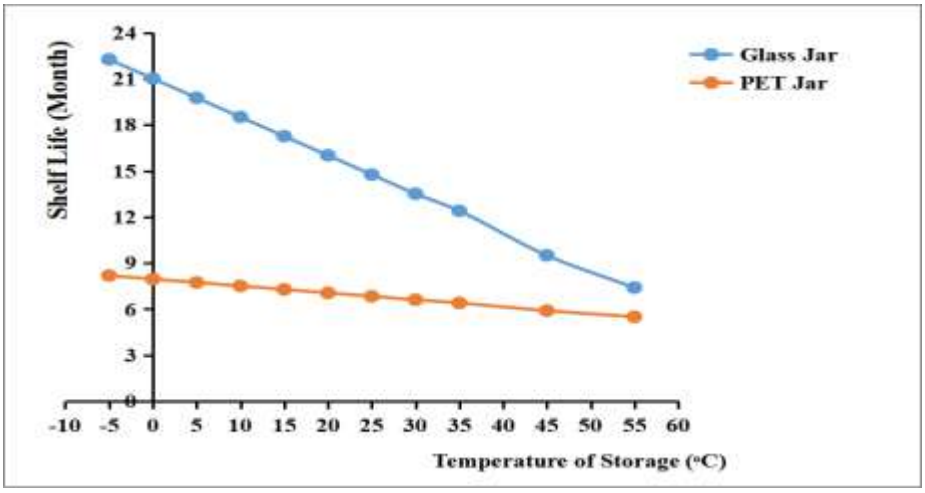

Figure 5. Shelf life prediction in different temperature and packaging

Table 4. Shelf life prediction of carica jam

Packaging	Temperature (˚C)	Shelf life prediction (months)
Glass jar	35	12.4
	45	9.5
	55	7.4
PET jar	35	6.4
	45	5.9
	55	5.5

CONCLUSION

The recommendations for packaging and storage conditions with consideration of efficiency and economics for carica jam is glass jar package at cold temperature (stored in the refrigerator). There will be no syneresis during storage at low temperatures (in the refrigerator) because kappa carrageenan and konjac glucomannan have been added. They were hydrocolloids that function to form and maintain a cohesive and chewy texture of jam.

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BACKGROUND

Carica is an indigenous fruit from Dieng plateau

It rich in Vit C, K, flavonoid, antioxidant, & dietary fiber

It can only be consumed after processing

One of the processed carica is cocktails which is made from unripe fruit

The use of over-ripe fruit and by product of cocktails production (pulp, seed) have not been carried out

Over ripe fruit have a strong flavor, soft texture, and become taint quickly when stored

A mixture of over-ripe carica fruit and its pulp can be used in jam production

Substitution of carica jam with chayote can reduce production costs

Chayote is rich in pectin and tasteless. Its suitable to be used as a substitute of carica fruit in jam production

BACKGROUND

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To extend shelf life and facilitate transportation and distribution, products were packaged with several package alternatives, such as glass jar and PET jar

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Shelf life needs to be determined to ensure product quality and safety for consumers

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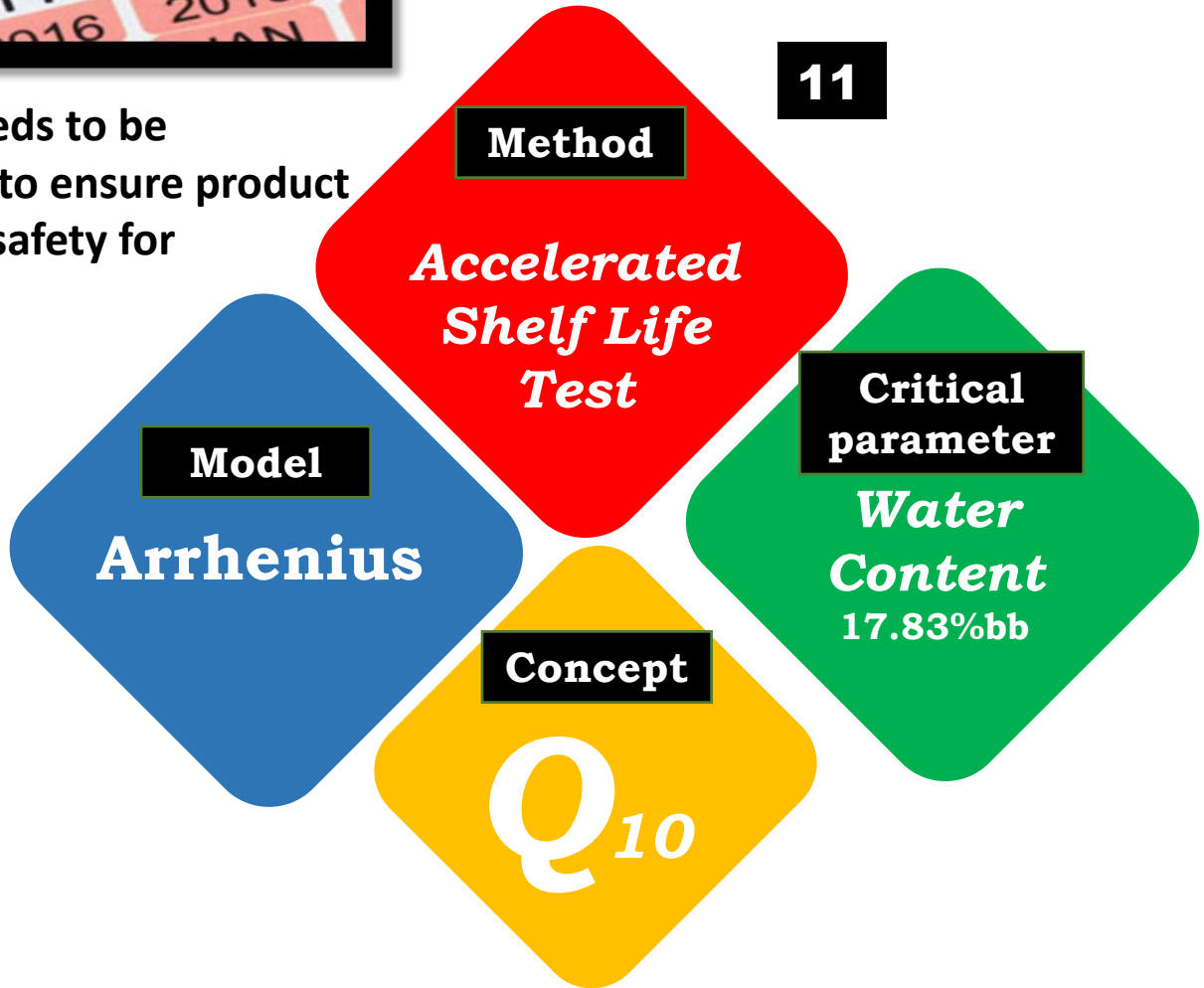


ASLT can predict the shelf life of a product quickly. Every 10oC increase in temperature, the rate of deterioration will be faster (twice). Spread ability used as critical parameter to determine shelf life

OBJECTIVE

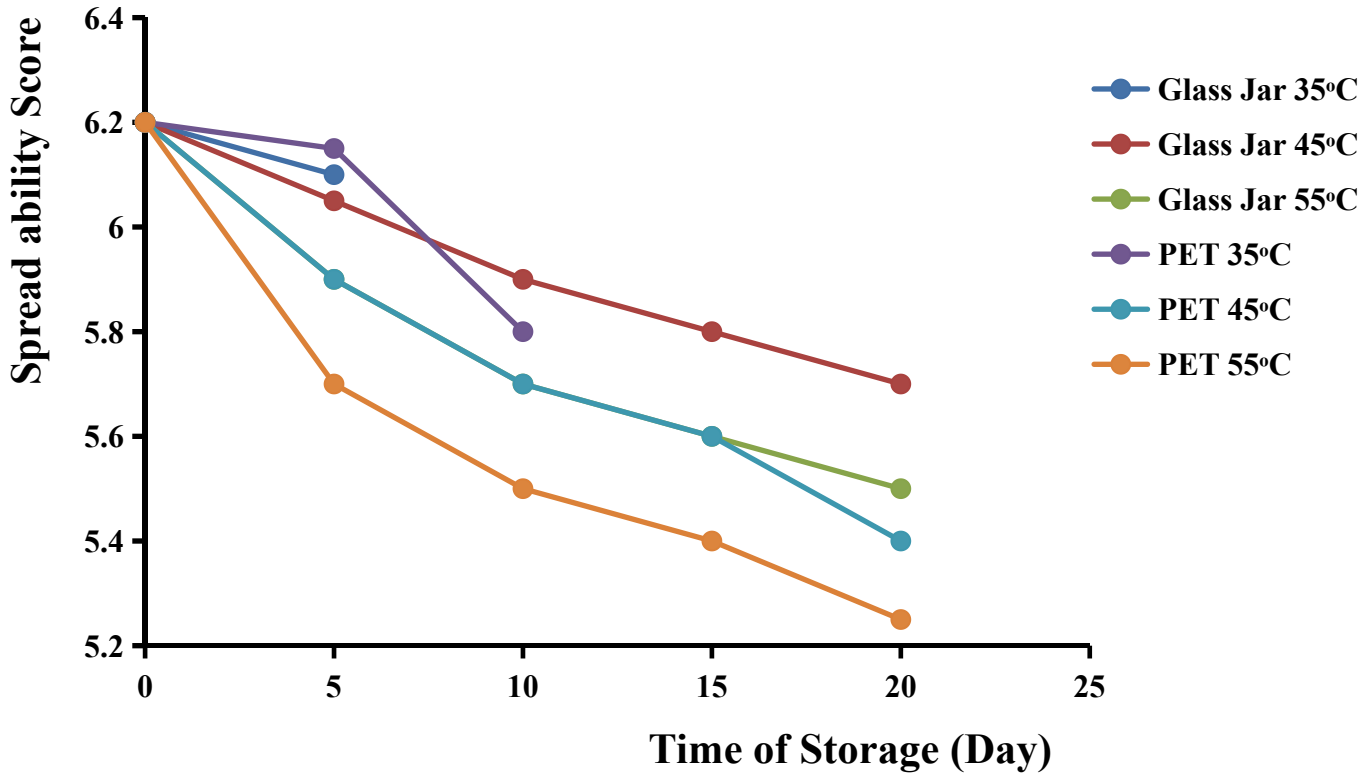
The objective of this research was to predict the shelf life of carica jam stored in glass jar and PET jar using the acceleration method and the Arrhenius model

Research Stages

1. Preparing materials. tools and other instruments
2. Making products with the optimum formula (results from previous research)
3. Packing the product in glass jar and PET jar
4. Storing the product in an incubator with a temperature of 35, 45, and 55oC
5. Testing spread ability of product at storage for 5, 10, 15, and 20 days; the experiment was repeated twice → by 10 trained panelist using scoring method in sensory test
6. Analyze and process data :determine the reaction order kinetics and Arrhenius equation
7. Determine the shelf life prediction of carica seeds powder

RESULT AND DISCUSSION

1. The profile of spread ability



- The results showed that the spread ability score decrease with the length of storage time and the higher in storage temperature.
- The decrease in the spread ability score during storage for products packed in PET jar was higher than those in glass jar
- At 35oC storage for 10 and 15 days, the products in the glass jar and PET jar had mold, so that the observation of the variables was stopped.
- Molds are mesophilic. They can grow at temperature with in the range 10-35oC

2. The determination of the reaction order kinetics

Packaging	Temp. (˚C)	Zero Order			First Order		
		Slope (k)	Intercept	R^2	Slope (k)	Intercept	R^2
Glass jar	35	-0.020	6.20	1	-0.003	1.824	1
	45	-0.025	6.18	0.988	-0.004	1.821	0.991
	55	-0.034	6.14	0.938	-0.005	1.811	0.946
PET Jar	35	-0.040	6.25	0.842	0.006	1.833	0.839
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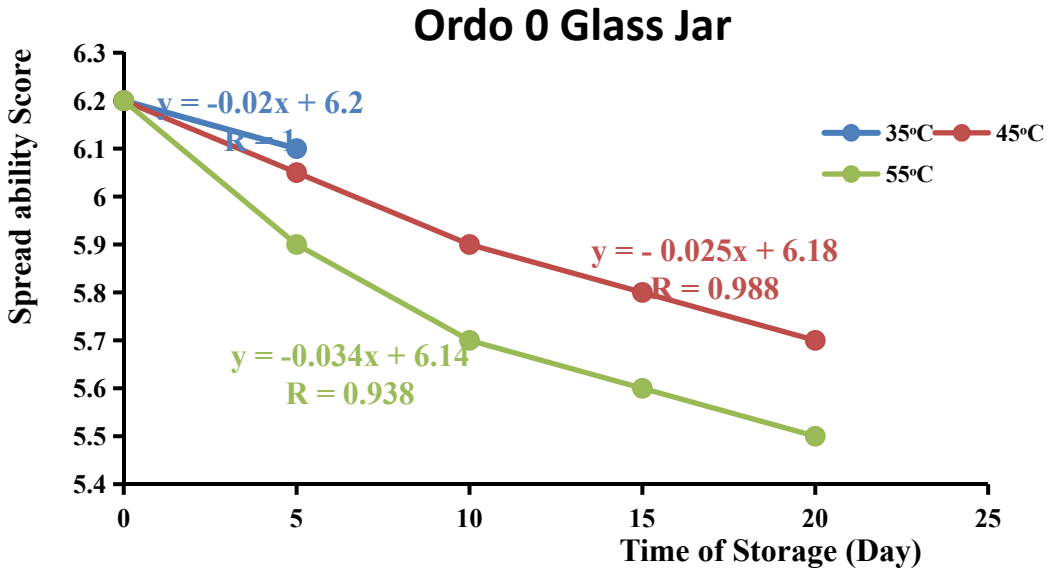
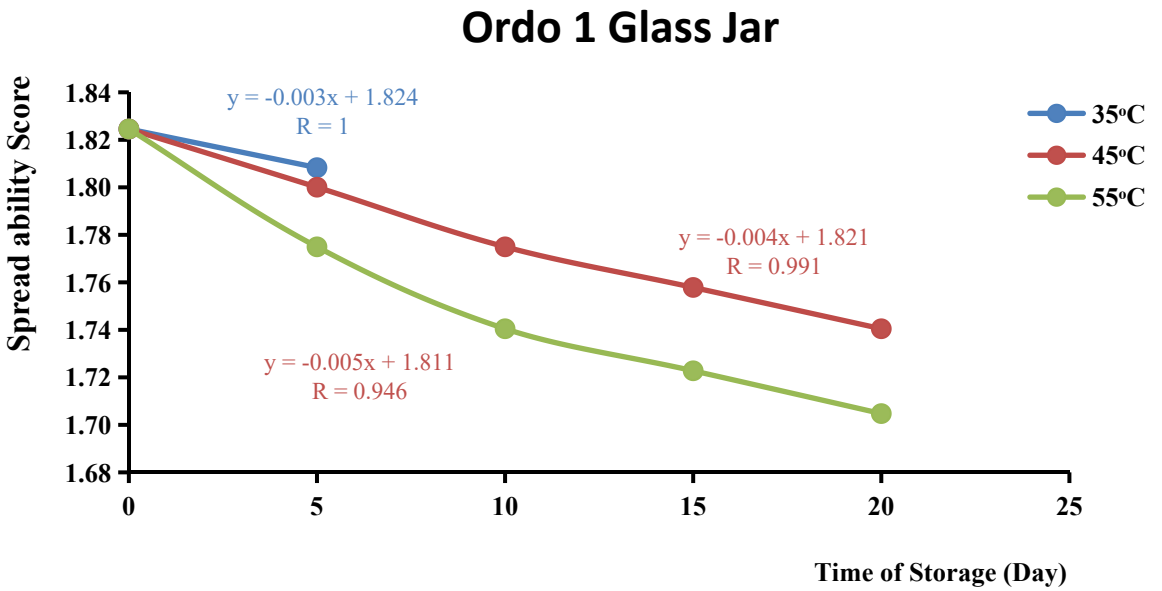
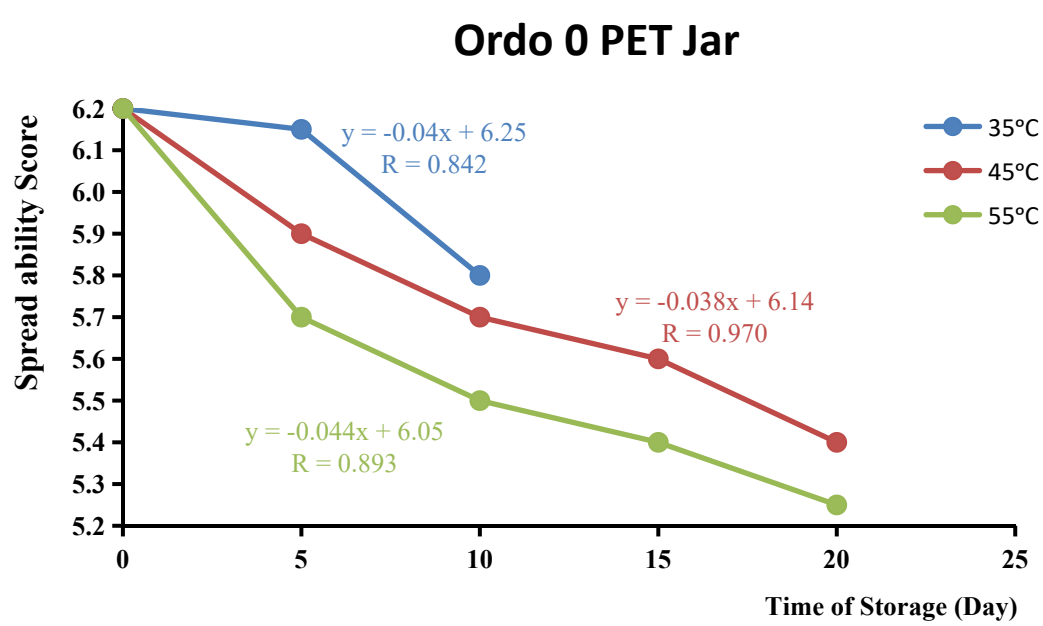
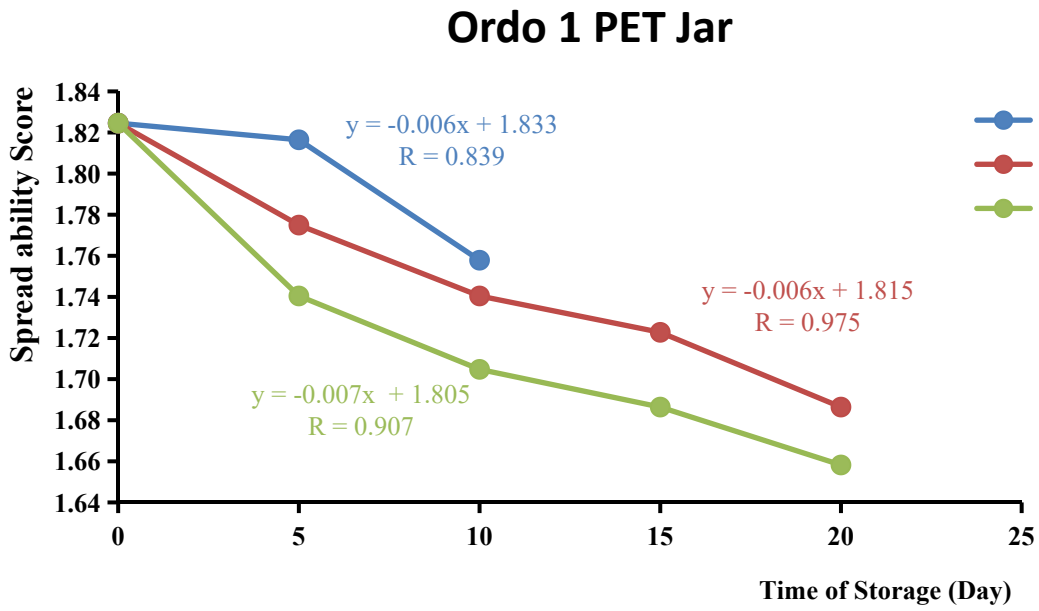
Based on the value of the highest correlation coefficient (R2). the reaction order kinetics selected based on the linear equation at the same temperature is the first order reactions.

2. The determination of the reaction order kinetics









3. The determination of Arrhenius Equation and "K" value

Packaging	T (˚C)	K	ln k	T (˚K)	1/T (˚K)	Linier equation ln K vs 1/T	Arrhenius equation ln K = ln K_0 – Ea/R
Glass jar	35	0.0030	-5.79	308	0.0032	Y = -2582x + 2.584 R^2 = 0.99	ln K = 2.584 + 2582x
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	45	0.0063	-5.06	318	0.0031		
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Packaging	Temperature (˚C)	ln K	K
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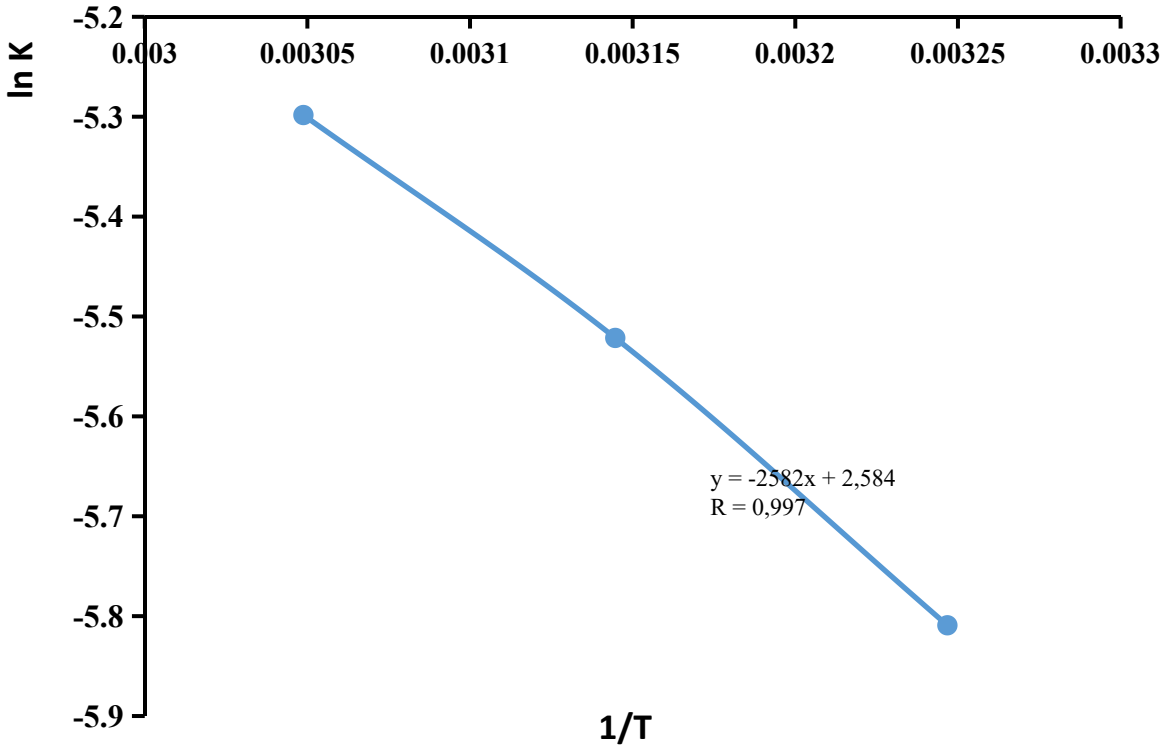
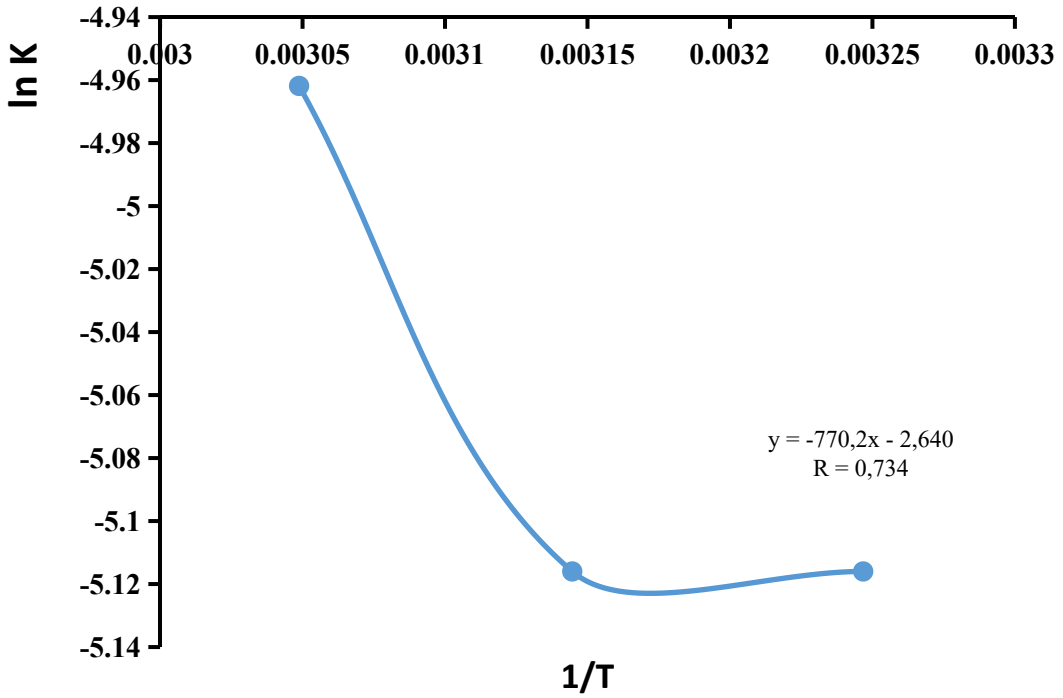
The curve of Arrhenius Equation

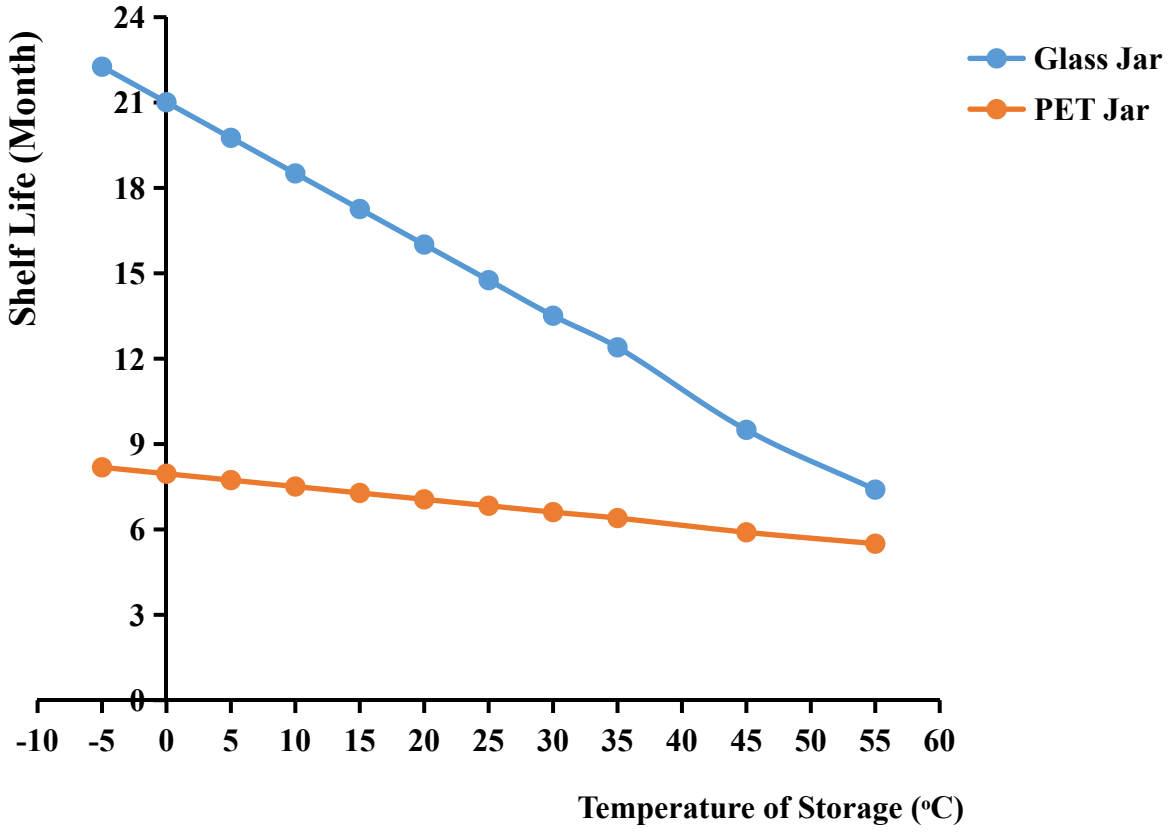


Glass Jar



PET Jar

4. The determination of shelf life prediction



Packaging	Temperature (˚C)	Shelf life prediction (months)
Glass jar	35	12.4
	45	9.5
	55	7.4
PET jar	35	6.4
	45	5.9
	55	5.5

CONCLUSION

1. The shelf-life prediction of carica jam packed with glass jar at room temperature (25^{o}C) was 1 year and 2 months and at cold temperature (8^{o}C) was 1 year 7 months; meanwhile, products packed in PET jar at room temperature (25^{o}C) was 6 months and at cold temperatures (8^{o}C) was 7 months
2. The recommendations for packaging and storage conditions with consideration of efficiency and economics for carica jam is glass jar package at cold temperature (stored in the refrigerator).
3. There will be no syneresis during storage at low temperatures (in the refrigerator) because kappa carrageenan and konjac glucomannan have been added. They were hydrocolloids that function to form and maintain a cohesive and chewy texture of jam.

Thank You






PATARA
Diena Exotic Fruit
Carica Jam
100 % Original
Netto: 250 g