International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 3; Issue 2; March 2018; Page No. 67-71

Shelf life prediction of eggplant by application of hydrocooling technics and various temperatures of storage

Maya Sari, Juliana Br Simbolon, Sumatera Tarigan
Lecture of Agriculture Produce Technology, University of Quality, Medan, Indonesia

Abstract
Eggplant is one of the horticultural commodities that commonly consumed by society. An appropriated postharvest handling of the produce, therefore, is needed to maximize get the best out of its utilization. The purpose of this research is developing of kinetic model to predict shelf life of eggplants and determining the best postharvest handling which can maintain its physical quality. Precooling treatment on this research is applied by using water in temperature of about 7ºC and the precooling time about 10 and 20 minutes, and then the produce storage in various temperatures of 7ºC, 15ºC and 28ºC. Changing of textures is analyzed by the kinetic variations and it is used to predict shelf life of eggplants. Results of the study showed that precooling treatments is able to decline the temperature of eggplants. The precooling and cool storing are also able to maintain fresh of the produce. Based on kinetic changes, shelf life of precooling eggplants in 10 minutes are 14 days, precooling in 20 minutes are 18 days and the non-precooling are only 5 days. Equations on this research are used to predict changing the physical quality and shelf life of eggplants.

Keywords: eggplants, precooling, kinetic of change

Introduction

Eggplant is a plant of shrubs which can grow around 60 – 90 cm of its height. The leaves of plant are wide and ear-shaped and the flowers are purple and complete, usually separated and formed in bunches of flowers. According to Sutarya and Grubbed (1995) [13], eggplant grows normally up to elevation of 1000 m asl, and in lowlands the plant is growth more rapidly. The appropriate temperature for eggplant is 25-30ºC with minor difference of day and night. It grows well on sandy clay soils with good drainage. Although eggplant requires a high temperature for growing, but it also exists to high rainfall as long as the soil does not tarnish. The harvesting shelf life of eggplants is depending on kinds, but commonly they can be harvested in three months (about 90 days) after established. The best time harvesting of eggplant is undeveloped whereas its seeds is not rigid yet and its fresh is not tough yet. The plant is better harvested in the morning or afternoon because its fruits that heating of sunlight would be easily damage and crinkle that reducing their quality. The fruits that had just harvested, therefore, must be evaded of sunlight in order to keep fresh and good quality of the produce. There are certain factors influencing the qualities of eggplant postharvest, temperature, respiration, and transpiration. The yield postharvest quality is relies on proper temperature either during the harvest, transport, or storage, prior the products is utilized. The high temperature commonly causes fast declining of produce's qualities, while the low temperature is likewise. The transpiration process is also impacted of the temperature whereas high temperature cause of high transpiration too.

Jha *et al*. (2002) [7] pointed out, the weight of eggplant that storing would be declines because of transpiration process. Transpiration is flow out of water from internal tissue of concerning plants products. The transpiration speed is influenced of both internal factors such as morphology/ anatomy, surface ratio to volumes, physical damages, and age of harvesting; as well as external factors such as temperature, RH, air movements, atmosphere pressures.

To sluggish of transpiration process, therefore, various post harvesting actions of eggplant is needed such as precooling and cool storage, to see and predict of shelf life of produce, based on altering of kinetics during in storing. In this case, hydrocooling technic is chosen for precooling process of eggplant, and then stored in several of temperatures.

Texture exchanging of kinetics

Texture exchanging of kinetics of eggplant throughout the storing can be distinguished by data of exchanging rigorous of the products that is seen by penetrometer. The first thing needed to know is the value of *k* (constant of speed exchanging) by variety of treatments and the temperatures. The value of *k* is obtained by drawing a graph of natural logarithm of texture exchanging for each of time [ln (dF/second)] versus the time of storing (t). Nevertheless, prior to that is needed to know whether the kinetic formula is linearly or not. If the formula is linear, hence the formula positioned on order 1 i.e. $n = 1$, such as presented in figure 1.

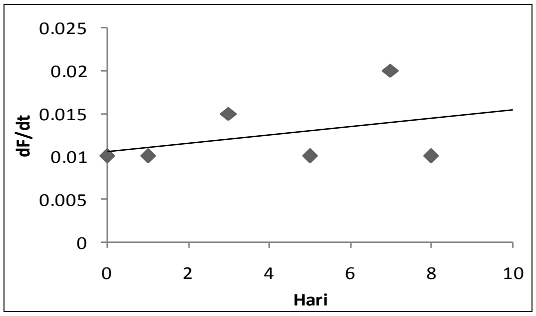

Fig 1: An Example Graph Plot of Texture Exchanging Throughout Storing

Thus, the kinetic formula becomes:

$$\frac{dF}{dt} = -kF^n$$

As n = 1, hence:

$$\frac{dF}{dt} = -kF$$

$$\frac{dF}{F} = -k.dt$$

$$\int_{Fo}^{Ft} \frac{dF}{F} = -k \int_{t=0}^{t=t} dt$$

$$lnFt - \ln Fo = -k.t$$

$$k = -\frac{lnFt - lnFo}{t} \qquad (1)$$

Shelf life prediction of eggplant

Shelf life of eggplant is predicted by observe of physical quality of the yield along storing. If physical conditions of eggplant is solid (is not lenient), hence the eggplant still good to consume. Generally, the value of solid of eggplant is 0,70 kg/m^2, measured by penetrometer, and the softness eggplant has value of solid is 0,58 kg/m^2. In this case, means that the produce is not good to consume. Based on the value of solid, the shelf life of eggplant is predicted by using value of *k* for the texture exchanging that following substituted to Arrhenius formula, such as follow:

$$k = Aexp^{-\frac{Ea}{RT}}$$

$$-\frac{lnFt - lnFo}{t} = Aexp^{-\frac{Ea}{RT}}$$

$$t = -\frac{lnFt - lnFo}{Aexp^{-\frac{Ea}{RT}}} \qquad (2)$$

Materials and Methods

The materials used in this research are purple eggplants from the traditional market of Pasar Pagi Demangan, Yogyakarta. The farmers harvested of the eggplant in the afternoon and packed in transparent plastics and carried by open pick up from an important growing area of Prambanan to the traditional market of Demangan, for about an hour. The eggplants used in this research weighting between 180 gr to 200 gr and the volume each of the fruit 220 ml. Water and ice cube for the treatment of precooling. The equipment used is cold storage, penetrometer, and thermocouple.

The eggplants bought from the traditional market of Demangan, packed in transparent plastics, and taken to laboratory at 06.00 a.m. in the morning. The samples is branded and named based on the treatments applied. Further, some of the eggplants is cleaned and submerged in cold water temperature of 7ºC for 10 and 20 minutes respectively, while the remains are not be precooling, used as controls. The cold water is obtained of poured 3-4 ice cube to 3 liters of water in an appropriate instrument. Post-precooling treatments is the eggplant stored in cold storage and in open room of laboratory TPP. The humidity of Cold storage is 80% and 60% for the TPP (room's) of laboratory. The temperature variations of storing eggplants in cold storage are 7ºC, 15ºC and 28ºC, and it is observed for 11 days.

To know the rigorous exchanging of the samples, I used penetrometer. The penetrometer basic operation is measuring propulsion in needed to penetrate the measured samples. The samples are stabbed in 3 difference spots, and the damages by the process are recovered. One eggplants only used once time to obtain the data, for the reason that the eggplants that had been stabbed is not be able to return to cold storage because the surface of the eggplants has ruined and contaminated by the open air.

Results and Discussion

Generally, the agriculture yields stored in cooler temperature to keep fresh of the produce before utilized. Temperatures optimum to store of fruits and vegetable is various. Some commodities cannot resistance to lower temperature. It is because the commodities cannot be metabolisms normally in lower temperature (Muchtadi dan Sugiyono, 1989) [10]. The damages of temperatures called chilling injury. The optimum temperature of eggplant is 7-10ºC for 14 days. When it stores in lower or higher than the optimum temperatures, the eggplants would be chilling injury i.e, freezing that triggering the eggplant is more solid/ hard. It is proven by the figure 2 a, b, c below.

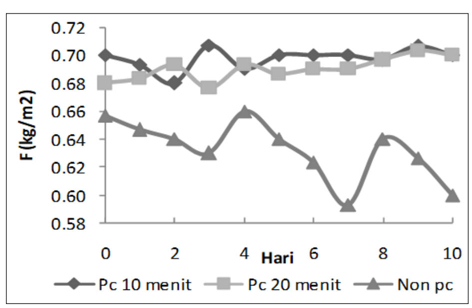

Fig (A)

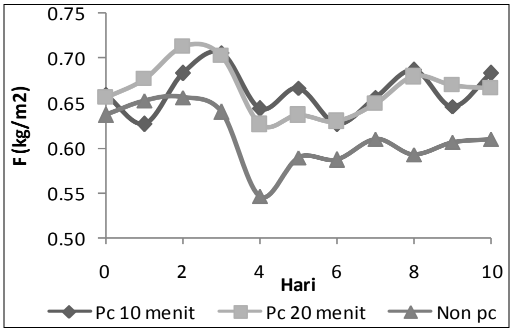

Fig (B)

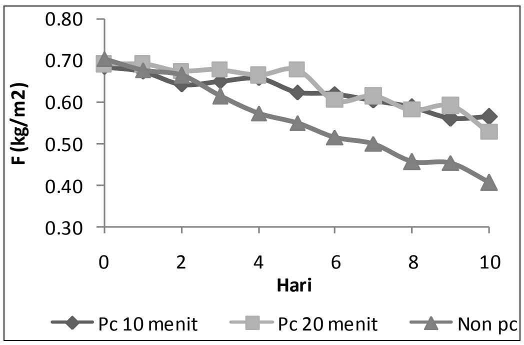

Fig (C)

Fig 2: a, b, c. Exchanging Rigid of eggplant in different temperatures, a. T 7ºC, b. T 15ºC, and c. T 28ºC respectively

Figure 2 shown that precooling in 10 and 20 minutes and stored in the temperature of 7ºC, the value rigid of eggplants in day 0 are 0, 70 and 0, 68 kg/m^2. When it is stored longer, the values of rigid are fluctuating exchange. Up and down of the values caused either of using penetrometer in obtaining data, whereas the equipment is stabbed in surface of the eggplants or because of the samples of eggplants that stabbed is different in each day.

Commonly the rigid of eggplant that is precooling is growth. This is shown at the end of storing, in tenth day, the value of rigid in each of precooling in 10 and 20 minutes are 0, 70 and 0, 71 kg/m^2. It is mean that when the eggplants is logger in storing, consequently it freezing. Buckle *et al*. (1985) [2] pointed out, store in freeze caused of texture exchanging such as lose of cloud, gel damaging, protein denatured, and rigorous. Meanwhile, on the sample of eggplants that is not precooled, solid of the eggplants would be declined and even rotten. The eggplants which not precooled have shelf life for ±18 days on the temperature of 7ºC.

In the storing temperature of T 15ºC, the rigid is not significantly exchange, but the data is fluctuated by the same caused of data obtaining in temperature of 7ºC (as in prior explanations). The eggplants stored in temperature of 15ºC be able to keep its fresh (see: figure 3.1(b). In precooling of 10 minutes the day of 0, the value of rigid is 0,66kg/m^2, and the day of 10 is 0, 67 kg/m^2. This means that the eggplant is better stored in temperature of 20ºC, the same thing in precooling of 20 minutes and those of non-precooling.

The declinations rigid are significantly occurred on non-precooling eggplants, but to those of precooling, the declination is slow. The declination rigid of the produce would be continued until they are rotten. It occurs by activity of rottener bacteria that are living and developing inside it. The bacteria needs subtracts of eggplant to grow up. When it happens, the produce would be changing physically or chemically until it is rotten. Enduring of physical quality of precooling eggplant indoor open room's is 7 to 8 days, while the non-precooling of eggplant is only maximum 4 days, and then it is rotten (see: figure 3). Besides of rottener bacteria, the transpiration is also one of the sources eggplant's texture become soft and wrinkle. Kader *et al*. in Sucahyo (1992), losing water by transpiration is one of the main reasons declining of quality produce, both losing of weight or changing of performance (withered and wrinkling), and the texture become softly. On room temperatures, the transpiration is faster.

Fig 3: Physical appearance of rotten eggplant

Model of shelf life prediction of eggplant

Regarding to exchange of rigid value of eggplants, the shelf life of produce can be predicted on the temperature of T 7ºC, T 15ºC and T room's with or without the treatment of precooling. The prediction used to know the strength of eggplant to reach inappropriate value (soft or withered). The observation results shown the value of Ft is the rigid value of eggplant of soft is 0, 56–0, 58 kg/m^2, while the first value of rigid (eggplant in fresh condition) is 0, 70 kg/m^2. The value of *k* then is obtained for each of temperature and precooling treatments using kinetic formulation.

The value of *k* accounted by plotting ln (Ft/Fo) *versus* time (t), then obtained the formulation y = ax, whereas y = ln (Ft/Fo), a is *k* and t is time. Here is an example of accounting the value of *k* for precooling of 10 minute, T room's (Figure 4).

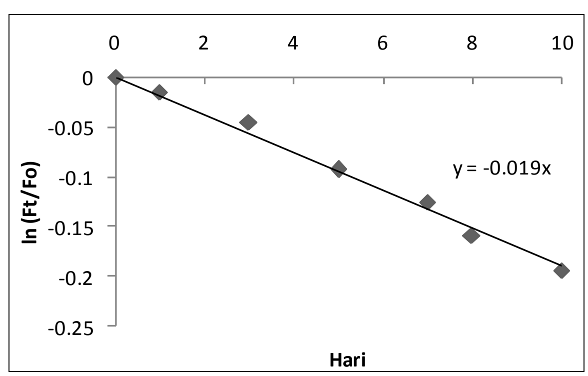

Fig 4: Curve of Connection of in (Ft/Fo) *versus* time (t)

From the Figure 4 obtained the formulation of y = -0,019x, it means the value of *k* = 0,019. The constant value of speed exchanging rigid of eggplant in precooling of 10 minute on T room is 0,019. With same steps then accounted the value of *k* for precooling of 20 minute and non-precooling in temperature of storage of 7ºC, 15ºC, and the T room

Table 1: The value of rigid exchanging of eggplant in various temperature and treatments

Treatments		Temperature	
	T 7 o C	T 15 o C	T rooms
Precooling 10 minutes	0.014	0.014	0.019
Precooling 20 minutes	0.008	0.008	0.02
Non precooling	0.011	0.013	0.051

The impacted of temperature to value of *k* then analyzed used the Arrhenius formulation. Results of the analyses obtained the activation energy value and the frequency of the pounding (Ea and A). The analyses done by plotting of ln k *versus* 1/T (K) using then a regression linear formulation to obtain the most appropriated line formula. To be cleared, see: Figure 5 a, b, and c

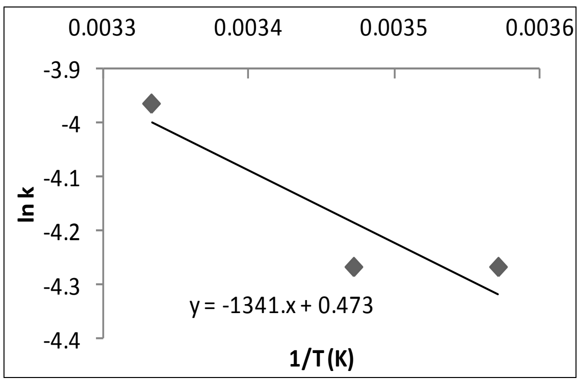

Fig (A)

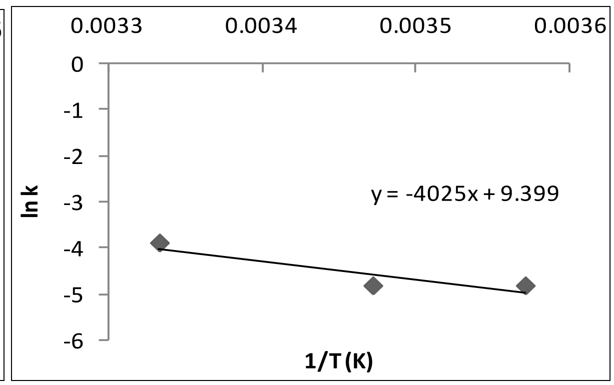

Fig (B)

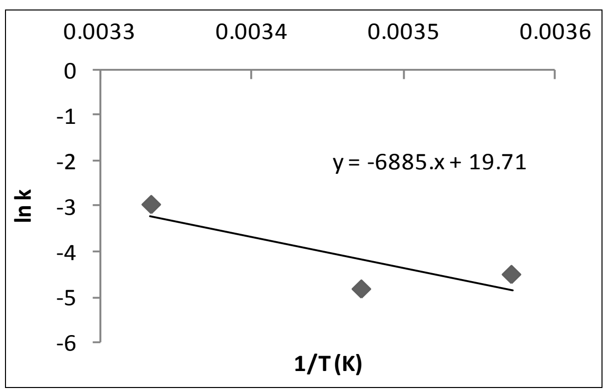

Fig (C)

Fig 5: Linear regression of ink *versus* 1/T (K) for (a) Precooling of 10 minutes, (b) Precooling of 20 minutes, and (c) Non-precooling

From the Figure 5 obtained formula of y = ax + b would be used to find the value of Ea. and A for each of treatments. The value of Ea. A, Ft, and Fo substituted to the formula of 1.2, the prediction shelf life of eggplant then identified. The eggplant in precooling of 10 minute and stored in temperature T of 7ºC, shelf life storage of produce is 14 days, while the eggplant of precooling of 20 minutes stored in the temperature of T15ºC would be shelf life until more than 18 days, and the eggplant of non-precooling stored in T room temperature, the fresh then only persist in 4 to 5 days. This formulation used to find shelf life prediction of precooling eggplant and not for the variation of temperature of 7-30ºC.

Table 2: Shelf ife prediction of eggplant

Treatment	Ea (kJ/kg mol)	A (1/s)	Prediction Formulation	Shelf Storage (days)
Precooling of 10 minutes	11149,71	16048	$t = -\frac{lnFt - lnFo}{16048exp^{-\frac{11149,71}{RT}}}$	14

Precooling of 20 minutes	33465,75	1207,29	$t = -\frac{lnFt - lnFo}{12076{,}2exp^{-\frac{33465{,}7}{RT}}}$	18
Non-precooling	57245,13	363031	$t = -\frac{lnFt - lnFo}{363031exp^{-\frac{57245{,}13}{RT}}}$	5

Conclusions

1. The shelf prediction storage based on the Arrhenius formulation of eggplant precooling of 10 minutes is $t = -\frac{lnFt - lnFo}{1.6048\ exp^{-\frac{11149.71}{RT}}}$, for precooling of 20 minutes is $t = -\frac{lnFt - lnFo}{12076.2exp^{-\frac{33465.7}{RT}}}$ and for the eggplant of *non precooling* is $t = -\frac{lnFt - lnFo}{363031\ exp^{-\frac{57245.13}{RT}}}$.
2. The best treatment to make longer of shelf life storage of eggplant is treatment precooling 20 minutes and continued by storing in temperature of 15°C.

Acknowledgement

Dr. Nursigit Bintoro, my Master's Degree Advisor, Head of Agriculture Technology Faculty of Gadjah Mada University, Head of Bukit Barisan Simalem Faundation, and the Director of University of Quality. Special thanks to Donatus Dahang who has reviewed and translated of the manuscript until it is published.

References

1. Apriyanti M. Analisis Matematis Laju Respirasi dan Perubahan Sifat Fisik Buah Tomat (Lycopersicon esculentum Mill) dengan Pengaruh Vibrasi dan Penyimpanan Suhu Dingin Tesis Pascasarjana UGM. Yogyakarta, 2013.
2. Buckle, *et al*. Ilmu Pangan. UI Press. Jakarta, 1985.
3. Concellon A, Anon MC, Chaves AR. Effect of low temperature storage on physcal and physiological characteristics of eggplant fruit (Solanum melongena L.) Food Chemistry, 2006, 389-396.
4. Hadiwiyoto S, dan Soehardi. Penanganan lepas panen 1. Departemen Pendidikan dan Kebudayaan, 1981.
5. Hardenburg RE, Watada AE, Wang CL. The commercial storage of fruits, vegetables and florist and nursery stocks. USA: USDA, ARS Agriculture, Handbook 66 (revised). 130 p. USDA, Agricultural Research Service, Washington DC, 1990-1993.
6. Heldman RD, Singh RP. Food process engineering, Second Edition. Avi Publishing Company, Inc. Westport. Connecticut, 1981.
7. Jha SN, Matsuoka T, Miyauchi K. Surface gloss and weight of eggplant during storage. Biosystems Engineering, 2002; 81:407-412.
8. Kader AA. Postharvest Technology of Horticultural Crops. Second Edition, University of California, California, 1992.
9. Mishra BB, Gautam Sharma, Arun S. Browning of fresh-cut eggplant: Impact of cutting and storage. Postharvest Biology and Technology, 2012; 67:44-51.
10. Muchtadi TR. dan Sugiyono. Ilmu Pengetahuan Bahan Pangan. Institut Pertanian Bogor, Bogor, 1989.
11. Rubatzky VE, dan Yamaguchi M. Sayuran Dunia, Prinsip, Produksi dan Gizi, Jilid Ketiga. Penerbit ITB. Bandung, 1997.
12. Ryall AL, Lipton J, Handling transportation and storage of fruit and vegetables, The AVI Publishing Company, Inc, Westport, Connecticut, 1972.
13. Sutarya R, dan Grubben G. Pedoman Bertanam Sayuran Dataran Rendah. Gadjah Mada University Press, 1995.
14. Tranggono dan Suhardi. Biokimia dan Teknologi Pascapanen. Pusat Antar Universitas (PAU) Pangan dan Gizi. Gadjah Mada University press, Yogyakarta, 1990.
15. Wills RH, Lee TH, Graham D, Mc Kasson WB, Hall EG. Postharvest, an Introduction to the Physiology and Handling of Fruits and Vegetables. New South Wales University Press, Kensington, Australia, 1981.
16. Winarno FG, dan Aman M. Fisiologi Lepas Panen. Sastra Hudaya, Jakarta. 1981.