International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

Studies on Packaging Material and Shelf Life Estimation of Ready to Use Indian Curry Base

S V Karadbhajne[1], S P Patil[2]

[1]Assistant Professor, Department of Food Technology,
Laxminarayan Institute of Technology, RTM Nagpur University, Nagpur (M.S.) India

[2]M. Tech Research Scholar, Department of Food Technology,
Laxminarayan Institute of Technology, RTM Nagpur University, Nagpur (M.S.) India

---

Abstract - *The static gravimetric method, along with the different salt solutions was used in a range of water activity of 0.50-0.90 at 37.8° C and 75 % RH to obtain the isotherm of the product. The isotherm obtained at 37.8° C was desorption J shaped curve represented as type III isotherm. The Equilibrium Moisture Content (EMC) was used to evaluate the shelf life of curry base at 37.8° C and 25° C and at 75 % RH. The shelf life of the product was studied by calculating Half Value Period (HVP) of the product which was packed in laminates for storage at 37.8° C and 25° C and 75 % RH. The product contained 36.62 % moisture content, 4.51 % volatile oil content and the peroxide value remained unchanged. As per HVP (150 and 188 days), shelf life of 212 and 262 days was estimated at respective temperatures and relative humidity.*

Keywords: *Sorption isotherm, Curry Base, HVP, shelf life, (k) packaging material constant.*

1. INTRODUCTION

Convenience food, or tertiary processed food, is food that is commercially prepared (often through processing) to optimize ease of consumption. Products designated as convenience food are often sold as hot, ready-to-eat dishes; as room-temperature, shelf-stable products; or as refrigerated or frozen food products that require minimal preparation. Convenience or instant food is the order of the day especially amongst the urban population. They are hard pressed for time and are willing to pay for good quality convenience food. Changing lifestyles and overall increase in the standard of living have witnessed substantial increase in demand for such items.

Curry base is a new type of convenience food. Curry base has been used in cooking for vegetarian and non-vegetarian recipes. The curry base is generally prepared as paste which is composed of spice such as onion, ground nut, ginger, garlic, dry mango powder, turmeric powder, chilli and its powder, cumin seeds, coconut, poppy seeds, cardamom, cinnamon, coriander seeds, etc. and makhana flour as a binding agent. Curry base preparation is pre-processing prior to main curry processing. It normally took 1 to 2 hrs for small serving preparation whereas 5 to 6 hrs when been done for large processing. The short shelf life of paste is generally due to the microbiological spoilage from moulds (Supachai Pisuchpen, 2008). To improve the consistency and body forming of the product, it is made by mixing it with makhana flour as a binding agent. The mix contains around 34 % moisture and 31% oil content. In addition, the water activity of mix is around 0.85-0.90 at its initial moisture content (Supachai Pisuchpen, 2008). Moisture content in food is one of the predominant factor affects the physical, chemical, microbial and sensory properties which are the key properties for consumers and shelf life (Robertson, 1993). The shelf life of the food can be predicted by the mass transfer characteristics of the package-product system (Supachai Pisuchpen, 2008). Winks weight equilibrium method (S. Ranganna, 1986) was used to determine the equilibrium moisture content of the product at 37.8º C and 50% to 90 % RH. The estimation of the shelf life of packaged food was done by using relation of half value period (Oswin, 1945) at 25 º C and 37.8 º C and at 75 % RH.

The objectives of this study were (i) to determine the equilibrium moisture content and (ii) to establish the shelf life of the packaged product.

2. Experimental

2.1 Materials

The materials used for the preparation of the mix were ginger, garlic, onion, groundnut, dalia, chilli and its powder, coconut, turmeric, salt, dry mango powder,

makhana, cumin seeds, cinnamon, black cardamom, coriander seeds and refined sunflower oil were procured from local market of Nagpur city. Chemicals used in this study were of laboratory grade procured from Fischer scientific Ltd.

2.2 Product

Firstly the spice mix formulation was standardized including ginger garlic paste (1.6:1) and paste of selective spices. The spices were oil roasted before preparing paste and later ginger- garlic paste and spices paste (1:6) were partially cooked and mixed (70-80˚C) and allowed to cool to room temperature before packing. The spice mixes were then enriched with additives like Makhana flour (5%), corn flour (5%) and edible gum (0.5%). All prepared samples were tested and compared with respect to physical, chemical and rheological properties. (S V Karadbhajne, Neha Saraf 2017)

2.3 Package

The selected of packaging material was laminate and low density polyethelene (LDPE). The selected materials were studied for water and gas permeability. In order to estimate the shelf life of the product three layer laminates were used as a packaging material. Outer layer of laminate is of PET, middle layer of Al foil and inner most layer is of LDPE material. Thickness of laminates was 60 µm.

2.4 Chemical composition

Freshly prepared sample and samples stored at 37.8º C and 25º C were used for the estimation of shelf life. Samples were analysed for chemical parameters viz., moisture content, total oil, peroxide value, and volatile oil using standards methods described by Ranganna (1986) (NarsingRao, 2011).

2.5 Water and gas permeability of packaging material

The water vapour transmission rate (WVTR) and oxygen permeability (OTR) of the packaging material (laminate & LDPE) was determined using WVTR and OTR measuring instruments at 35°C and at 0°C and 90% relative humidity.

2.6 Sorption Isotherm

The equilibrium moisture content of developed product was determined at 37.8º C by static gravimetric method. The weighed sample was exposed to different relative humidity conditions ranging from 50 to 90 % RH using salts like sodium dichromate ($Na_2Cr_2O_7$), sodium nitrite ($NaNO_2$), sodium chloride (NaCl), potassium chromate ($K_2Cr_2O_4$), ammonium phosphate ($NH_4H_2PO_4$) at 37.8 º C (S. Ranganna, 1986). The samples were weighed and placed into the desiccators at different humidity. The moisture desorbed by sample was determined at regular intervals until the sample equilibrated to constant weight (Narsing Rao, 2011). The equilibrium was reached by 12 days for desorption. The sample was observed critically for adverse changes like discoloration, off odor and mold growth during study.

2.7 Estimation of HVP and Shelf life of packaged product

In this experiment, Product Equivalent Method (PEM) was used to calculate the half value period. In this method, the moisture gain or loss of the package in addition to that of contents is considered (S. Ranganna, 1986).

The half value period was calculated using the following relation as (S. Ranganna, 1986).

$$M = \frac{M_0 W_0 - 100\,X}{W_0 - X}$$

Where,

M= Moisture content at each relative humidity
M_0= Initial moisture content
W_0= Average effective initial weight
And calculated as

W_0= Initial Wt. of product – Wt. of empty package+ Product equivalent Wt. of Package

X = Loss or gain of moisture

By plotting the graph of log (M-Me) vs days and slope of the resulting line will give HVP as

HVP = log 2/s

s= Slope of the line

Then the half value period obtained was used to estimate the shelf life of the packaged product using relation (S. Ranganna, 1986).

$$\text{HVP at t°C} = \text{HVP at T°C} \times \left[\frac{\text{Water vapour pressure at T°C} \times k}{\text{Water vapour pressure at t°C}} \right]$$

k= constant for packaging material.
And by plotting graph of log ($M-M_e$) vs time, shelf life was estimated.
Where,
M = ($M_0 M_{HVP} and M_c$)
M_0= Initial moisture content
M_{HVP} =Moisture content at HVP
M_c =Critical moisture content of the sample

3. Results and Discussion

3.1 Chemical composition

Data obtained from the chemical analysis of curry base was reported in Table 1.

Table 1. Proximate Composition of Curry Base

Test Parameter	Test Result
Moisture (%)	36.62
Ash (%)	3.6
Protein (%)	6.39
Crude Fat (%)	35.01
Crude Fibre (%)	1.1
Carbohydrate (% by difference)	17.29

During the study, samples were kept at 37.8º C and 25ºC and at 75 % RH. The moisture content and peroxide value of the samples were not significantly varied from that of initial values throughout the study. Total oil content of the samples varied 3- 4 % due to sample handling for analysis and some of oil remained stuck to the packaging material. The volatile oil content estimated was approximately unchanged and average volatile content was 4.51% indicating better barrier properties of packaging material.

3.2 Water and Gas permeability of packaging material

The dart impact, seal strength, peel bond strength and tensile strength of laminate and LDPE along with the water and gas permeability of test film is determined and reported in Table 2 and Table 3. Seal strength property of packaging material suggests the amount of effort to regulate heat and setting the temperature on a controller of a packaging material. The heat must be sufficient to penetrate from the jaw through the film or laminate to sealant layer and not so high that it damages the film or laminate.

Tensile properties are an important and common way to compare physical properties of packaging material from steel to plastic. Tensile strength provides measurement of attributes such as strength, stiffness and resistance to stretching.

Table 2. Packaging Material Properties

Test	Material	
	Laminate	LDPE
Dart Impact	500 gm	350 gm
Seal Strength	3.5 – 4 kgf	0.8 kgf
Peel Bond Strength	0.15 kgf	N. A.
Tensile Strength	5 kgf	0.1 kgf

WVTR: Water Vapour Transmission Test is the standard by which films are compared for measuring their ability to resist moisture transmission. Lower values indicate better moisture protection. Values reported in table 3 are measure at the same temperature and humidity because transmission rates are affected by the both parameters

OTR: Oxygen Transmission Rate is the steady state rate at which oxygen gas permeates through a film at specified conditions of temperature and relative humidity. OTR ($cc/m^2/24$ hrs) SI Units, oxygen gas is a reactive compound that is a key player in food spoilage. Most of the chemical and biological reactions that create rancidity of oil, mold and flavor changes required oxygen in order to occur. So OTR should be minimum for food packaging material to reduce oxygen exposure and to extend the shelf life of oxygen sensitive product.

With the help of WVTR measuring instrument at 35°C and 90% RH for 24 hrs and OTR measuring instrument at 23°C and 0% RH for 24 hrs. The permeability is temperature dependent and increases with the temperature. It can be inferred that test film (laminate) had better barrier properties to WVTR and OTR.

Table 3. WVTR and OTR of Packaging Material

WVTR @ (35⁰C), 90% RH			OTR @ (23⁰C), 0% RH
Test film	**Thickness (µm)**	**Permeability (gm/m²/24 hrs)**	**(cc / m²/24 hrs)**
PET	12	40	4.7
MET – PET	20	0.7	5
Total Laminate	60	0.5	5
LDPE	100	18.75	7500

3.3 Sorption Isotherm

The equilibrium moisture content and relative humidity data for food materials is essential to evaluate the storage characteristics under different environmental conditions (Narsing Rao, 2011). Isotherm was drawn to evaluate the hygro scopicity or hygro emissivity of the curry base. The isotherm obtained for the product at 37.8°C was desorption isotherm. According to Brunauer et al (1940) classification, isotherm obtained was of type III. The characteristic shape of the isotherm obtained will be because of quantity of hygroscopic and hygro emissive content present in sample. The mix had an initial moisture content of 36.62 %, which equilibrated at different humidity's ranging from 50 to 90% RH. The equilibrium moisture content of mix decreased slowly in the range of 0.85-0.90 a_w and rapid change was observed in the range of 0.50-0.75 a_w (Supachai Pisuchpen, 2008).From the data obtained, initial point (I)-moisture content of product, Critical point (C)-where mold growth found and Danger point (D)-5 % higher RH than C were determined. The critical point had 85 % RH, so the danger point was at 89.2 % RH.

3.4 Half value period (HVP) estimation

Table 4. Experimental data of laminated packed product for HVP estimation

Temperature (⁰C)	Days	Moisture Content (%)		
		M	Me	Log (M – Me)
25	5	36.26	5.731	1.4847
	10	36.07	5.731	1.4820
	15	35.73	5.731	1.4771
	20	35.08	5.731	1.4676
37.8	5	36.5	5.731	1.4881
	10	36.45	5.731	1.4874
	15	36.37	5.731	1.4862
	20	36.29	5.731	1.4851

HVP enables the estimation of package efficiency and shelf life in relatively short period of time. To estimate the HVP, the moisture gain or loss was measured at each interval of storage at both temperatures till the constant weight obtained. The HVP was estimated by calculating moisture content at each relative humidity and average effective initial weight of the product. The values so found were used to estimate the HVP by plotting log ($M-M_e$) vs Days and slope of the resulting line will give the HVP at the respective temperatures. From the Figure (2.) and Figure (3) the HVP at 25° C and 37.8° C was 188 days and 150 days respectively.

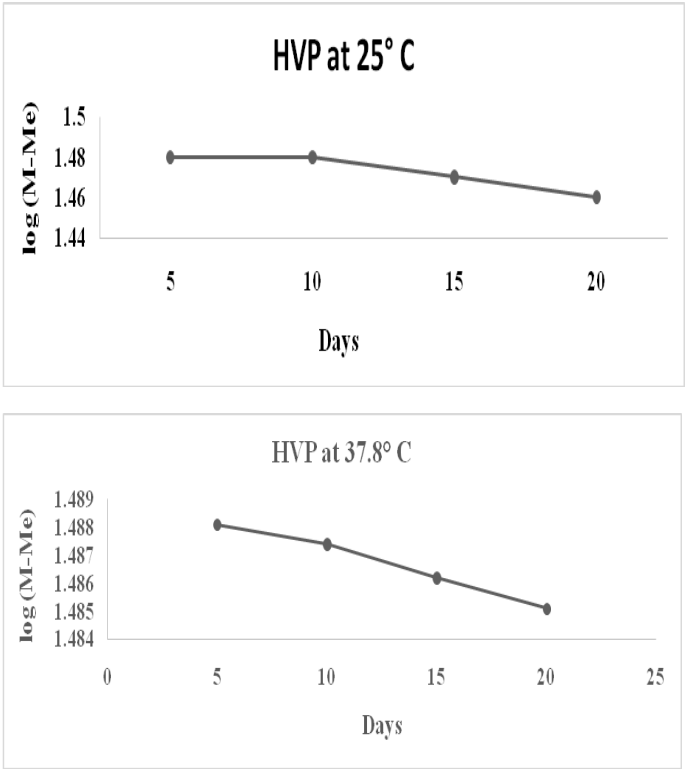
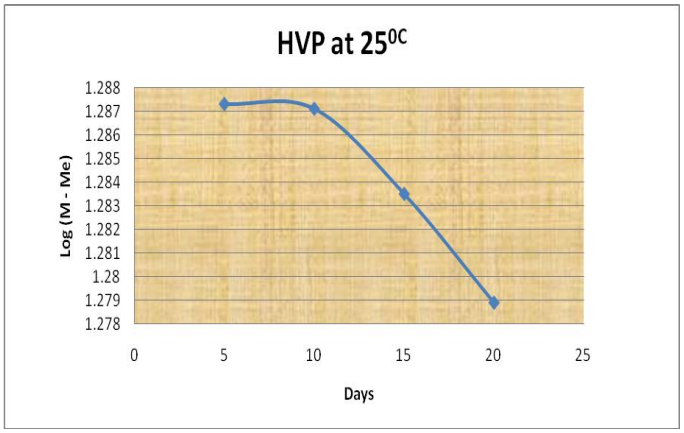


Figure 1. HVP of laminate packed curry base at 25⁰C and 37.8⁰C

Table 5. Experimental data of LDPE packed product for HVP estimation

Temperature (^{0}C)	Days	Moisture Content (%)		
		M	Me	Log (M – Me)
25	5	36.55	17.05	1.2900
	10	36.47	17.05	1.2882
	15	36.59	17.05	1.2864
	20	36.35	17.05	1.2855
37.8	5	36.43	17.05	1.2873
	10	36.42	17.05	1.2871
	15	36.26	17.05	1.2835
	20	36.06	17.05	1.2789



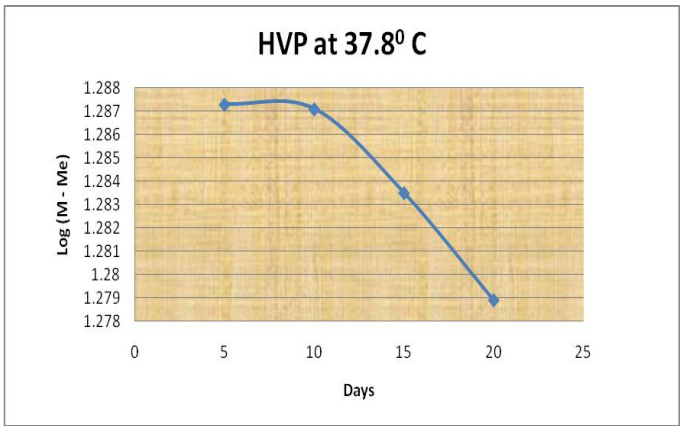


Figure 2. HVP of LDPE Packed curry base at 25^{0}C and 37.8^{0}C

3.5 Estimation of shelf life of curry base

The quality deterioration is in the form of an overall shelf life i.e. end point analysis as a function of storage temperature. The shelf life estimation at 25°C and 37.8°C gives the response ratio of the food to change in environmental temperature as well as the heat transfer properties of the food as well as the package (Cairnes and Gorden, 1976). Different packaging materials have different values of k and packaging material constant k of used laminates was calculated and having value of 0.31. The graph of log (M-M_e) vs time (Figure 4 and 5) where values of M (M_0, M_{HVP}, M_c) were 1.4898, 1.1887 and 1.0614 evaluated that curry base had shelf life of 262 days (8.7 months) at25° C and 212 days (7 months) at 37.8° C respectively. The product contains spices, so has good antimicrobial properties as well as antioxidant properties which retain the quality and class I preservatives like oil and salt, accelerates the shelf life of curry base. The quality and shelf life of product may be affected due to non-enzymatic browning reaction, lipid oxidation and change in water and gas permeability of package with the increase in temperature. So the increase in temperature reducing shelf life at 37.8°C compared to 25°C. The HVP relation can be considered as a reliable tool for predicting the shelf life of curry base paste for different packaging materials

Table 6 . Packaging Material Constant Values

Packaging Material	Values of Constant "k"
Laminate	0.31
LDPE	0.39

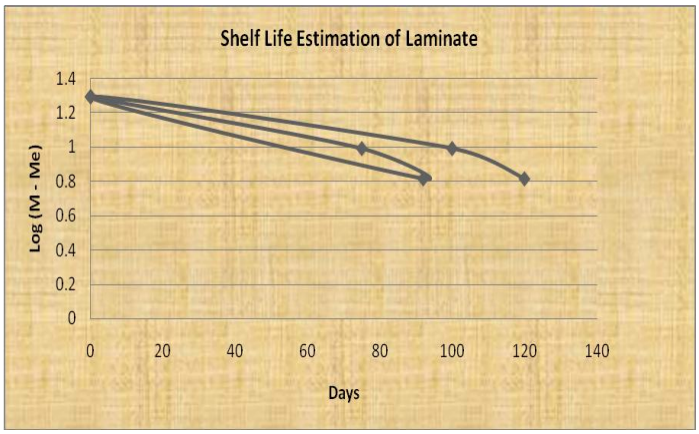


Figure 3. Graphical Representation of Shelf Life Estimation of Laminate Packed Product at 25^{0}C and 37.8^{0}C

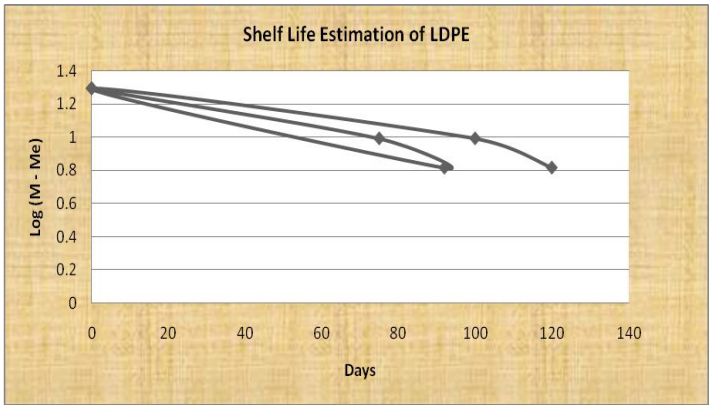


Figure 4. Graphical Representation of Shelf Life Estimation of LDPE Packed Product at 25^{0}C and 37.8^{0}C

4. Conclusion:

The isotherm provides crucial information regarding the desorption behaviour of the curry base. It manifests the quality, selection of packaging material and shelf life of the product. The shelf life was better evaluated by calculating sorption isotherm, 'k' constant for packaging material and physico-chemical changes taking place during storage. The packaging material laminates are thus, best suited for such non-Newtonian product to better shelf life. The isotherm was analysed for the estimation of the HVP of the product at 37.8° C and 25° C. The shelf life values so obtained from HVP indicate that curry base has good stability at room temperature without addition of preservative. Thus the product been commercially prepared and with the proper packaging can be store more than 8 months as convenience food.

5. References:

1. Balaswamy, K., Satyanaryana, A. and Rao, D. G. 2004b. Studies on preparation and storage characteristics of onion (Allium cepa L.)- Chilly (Capsicum annuum) chutney. Foodservice Research International 15: 140146.

2. Kaplow, M. (1970), Commercial development of intermediate moisture foods, Food technology, 24,889.

3. Gunthllake K.D.P.P, Bandara A.G.A. 2005. Preparation of a ready to eat coconut cum spices paste for chicken curry and evaluation of its physico-chemical and storage properties. COCOS, 17: 21-29.

4. labuza, T. P. (1984) Practical aspects of moisture sorption isotherm measurement and use. American Association of Cereal Chemistry, St Paul, MN.

5. Labuza, T. P., Fu, B. (1993). Shelf life prediction: theory and practice. Journal of Food Control, (4): 125-133.

6. Landrock, A. A. and Procter, B. E. 1951. A new graphical interpretation method for obtaining humidity equilibrium data, with special reference to its role in food packaging studies. Food Technology 5: 332-337.

7. Lawson, W.W. (1991). Standards for Fats & Oil, Westport, Connecticut: AVI publishing company, INC.

8. Narsing Rao, G., Prabhakara Rao, P. G., Jyothirmayi, T. and Rao, D. G. 2008. Chemical composition, standardization and storage studies on raw mango chutney powder. Journal of Food Science and Technology 45(5): 436-438.

9. Narsingrao, G., Prabhakara Rao, P.G.Balaswmy, K. and Rao, D.G.2011. Preparation of instant tomato pickle mix and evaluation of its storage stability. International Food Research Journal 18: 589-593.

10. Pruthi, J.S. (1998).Spice and condiments, National Book Trust, New Delhi

11. Ranganna, S. 1986. Hand Book of Analysis and Quality Control for Fruits and Vegetable Products (2nd Edn). Tata McGraw-Hill Publishing Company limited, New Delhi.

12. Robertson, G.L. (1993). Food Packaging: principles and practice,1st ed. Marcel Dekker, New York, p.339-344.

13. Sapachai Pisuchpen 2008. Shelf life analysis of hot curry cubes. As. J. Food Ag-Ind.1 (01): 43-50.

14. S V Karadbhajne, Neha Saraf, Determination of physical, chemical and sensory characteristics of instant curry mix for vegetarian recipes, International Journal of Food Science and Nutrition, Volume 2; Issue 6; November 2017; Page No. 181-186

BIOGRAPHIES

Dr. (Mrs.) Sneha V Karadbhajne

Assistant Professor, Department of Food Technology, LIT RTM Nagpur University

Email: svklit@gmail.com

Life Member of AFSTI, NSI and IWSA

Teaching Experience to UG, PG Students: From 2003 to Till Date

Research Supervisor in Subject Chemical Technology, Faculty of Science and Technology