

**Performance of different packaging materials in stabilizing  
hygroscopic foods at different Humidity conditions**



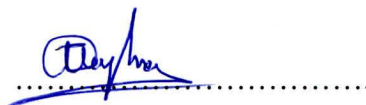
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**Thesis submitted for the award of MSc degree in Polymer Science  
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**2007**

## **Declaration**

“The work describes in this thesis was carried out by me under the supervision of Dr K.K.D.S Ranaweera, Head of the Department, Food science and Technology, University of Sri Jayawardenapura and Mr W.L.G Boteju, Technical Director, varna Limited . This report has not been submitted for in whole or part to any other univesity or any other institution for another degree.”

A handwritten signature in blue ink, appearing to read 'Tharangalal Mayadunna', is written above a horizontal dotted line.

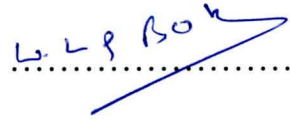
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## **Performance of different packaging materials in stabilizing hygroscopic foods at different humidity conditions**

**Tharangalal Mayadunna**

### **ABSTRACT**

Selection of the suitable flexible packaging material or material combination (Laminate) for packaging of hygroscopic food product is of paramount importance from manufacturer's and customer's points of view. Five types of flexible packaging materials namely LLDPE, OPP, PET/LLDPE, OPP/OPP, PET/Alu/LLDPE were selected for the present study. These materials belong either to single film, double laminate or triple laminate category. Using these packaging materials, two types of commonly consumed hygroscopic foods namely biscuit and rice flour, were packaged. Standard saturated salt solutions of  $MgCl_2 \cdot 6H_2O$ ,  $K_2CO_3$ ,  $Na_2Cr_2O_7$ ,  $NaCl$  and  $BaCl_2 \cdot 2H_2O$  were used to create five different RH levels 32.0 %, 43.6 %, 52.0 %, 75.6 % and 88.0 % respectively in an enclosed microenvironment. Samples of biscuits and rice flour were packaged using the above material combinations, and each sample was exposed to the above RH levels for maximum ten days, ten weeks and twenty weeks for single film, double laminated, and triple laminated materials respectively. Subsequently, the moisture content of each sample was measured by using oven method. Data obtained were used to plot the isotherms of ERH vs EMC (Equilibrium moisture content) under each packaging material.

The graph of ERH vs EMC and results obtained clearly showed that the foods packaged in single flexible films like LLDPE, OPP reach the EMC within short period of time, Hence

these packaging materials were found not suitable for packaging products which need to be kept longer, as the RH levels of Sri Lanka is considerably higher. It was evident that the triple laminate has taken the longest time period for the contents to reach the EMC. Results obtained with relation to all RH conditions statistically confirmed that rice flour and biscuits packaged in single and double laminated films had an increased weight due to absorption of moisture whereas triple laminated showed this increase only at higher RH levels like 75 % and 88 %.

Studies also further revealed that the triple laminate film under low RH levels behaved as a 100% moisture barrier. Hence, the triple laminate films can be considered to be the most suitable flexible material for packaging of any food product as it extends the shelf life of the food. Despite the best performance of triple laminates, double laminated films can be recommended as more suitable for a wider use when the prices are concerned, because the larger the number of films the higher the price of materials. However, for fast moving commodities, low cost single or double laminated films can be recommended as suitable packaging materials. It can be also noted that, using less layered laminate films in place of the required ones considering only the cost factor can affect the shelf life of the food commodity.

## CHAPTER 1

### Introduction

Today the people's needs for the foods are different. Now people live in a society that every body cannot manufacture each food which they consume. Instead of all communities manufacturing all goods for their residents they have to buy them in some where else. According to the today's market, customer should be received superior quality foods. Today customer satisfaction is not enough. Product should overwhelm the Consumer With the utmost quality. Therefore manufacturers of food have to pack and send their product with right means of packaging to achieve this goal.

Packaging can be considered as old as thinkable human. Primitive humans used leaves hollows gourds and other containers to carry food and water from place to place.

By today humans have coming through clay, glass, metal containers to plastic age. Today plastic is used enormously and Plastics are emerging as a vital tool for packaging manufacturers in reducing packaging weight, eliminating design constraints and promoting new packaging solutions, while also assisting food manufacturers in preserving their products longer.

When the packaging world is concerned there are three types of packaging basically available as a whole. First one is the Flexible packaging such as bags, pouches, and sachets. Second one is Semi rigid packaging such as corrugated fiber boxes, Box boards...etc. Third

one is Rigid packaging such as Plastic bottles, containers, crates, pallets, wooden boxes.

Depending on the application two types of packaging is available

(a).Consumer packaging - Packaging materials directly come in to contact with the food. Therefore this type of packaging is directly involved with humans .Hence this type bear paramount importance to all of the other types .Humans use skin to sense softness (tactition or mechanoreception) ,mouth to taste (gustation), nose to smell (olfaction) ,eye to view (vision) and ear to hear (audition). All humans use all of these sensory organs to evaluate the quality of the item they consume .Therefore, the all the characteristics should be satisfied and overwhelmed to attract the attention of the human. Therefore this type has competition to dominate over the other.

(b).Transport packaging – These materials are used for easily and safely moving the products from the manufacturer, perhaps to a warehouse, then to the retailer and finally, to the consumer. Perhaps the manufacturer and consumer may be in the two ends of a country

The basic function and purpose of packaging is to provide the protection for enclosed product which is confined to a microenvironment from the environmental factors such as dust ,water vapors ,gases ,microbes ..etc while retaining the quality characteristics of the enclosed product such constitutes imparting aroma and taste. The texture, composition of the food product may be drastically affected by the gases and water vapor in the environment and food product can undergo degradation causing processes like rancidity or gas production .These factors lower the sensory qualities like crispiness, mouth feel by being soggy .Therefore spoiled foods of this nature become not attractive to consumers. With respect to the protection, the barrier properties of the packaging materials such as

permeability property for gases, water vapor and retention property of the packaging materials bear utmost importance. Now world changes from the sales person mode to self-service, the package is needed to inform and sell the product With 10,000 products available in today's typical supermarket in addition to serving for basic functions.

When food packaging is considered the important factor to be considered is the shelf life of the product i.e. the length of the time it is acceptable for the use without affecting the customer perception through the perceptive stimuli of the end user. The degree of protection provided by the packaging against environmental factors that can decrease with the shelf life of the product is an obvious factor to be considered. Today the package designers are planned to reflect the many changing social and economic trends in the world. Several of those trends and resulting examples include:

- health consciousness (nutrient and additive contents)
- family size/singles (different portions)
- economy/price (various sizes, quality levels)
- mobility (convenience items, readily dispensing feature)
- novelty (for new forms of foods)
- labeling requirements (contents and directions)
- available equipment (products for the freezer or microwave)
- time and convenience to purchase and use (various available sizes, complete meals in a package)

- consumerism (easy opening features. consumer complaints have the highest influence on pharmaceutical and health-related products)
- customs and social habits (beverage packaging)
- environmental concerns (reduced, reusable and recyclable packaging)

Different types of packaging films have different properties, and are applied for different purposes, but in general Flexible packaging film is expected to exhibit following properties. These Properties include good Tensile strength, Elongation, Tear strength, Impact strength, ESCR, slip, Surface tension wetness, hot tack, Thermal, photo or bio degradability and sealability..Etc. When designing a package for food product, there are different aspects to be taken in to consideration. These aspects include

- Removing of water which may cause the food stuff to become wilt, dry or apparent change in color...etc.
- Absorption of water which may cause to become soaked, sweet or pungent...etc.
- Removing of air which may cause flavor, aroma, taste loss...etc.
- Reacting with oxygen which may cause oxidation, rancidity ...etc.
- Exposing to sun light which may cause spoiling, color change...etc.
- Restriction to respiration which may cause spoilage.
- Attack by microorganisms which may cause spoilage.

When designing package for food product barrier properties expected by different products to be considered as follows.

- Vegetable and fruits- oxygen permeability, water barrier properties