Shelf Life Evaluation of Instant Pasta in Two Different Packaging.

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Abstract. The objective of this study is to evaluate shelf life of instant pasta which had been packed in two different packaging, type I is an OPP/MCPP sachet and type II is an OPP/CPP sachet, under accelerated condition (37°C, 85%RH) for 12 weeks. There were 2 index which were used to evaluate the shelf life, one was sensory tests and another one was moisture content in pasta. Assessed by sensory tests, the shelf life of instantly cooked pasta packed in type I and type II sachet, were revealed more than 12 weeks and equal 12 weeks, respectively. Likewise, the shelf life predicted on the basis of moisture sorption isotherm and water permeability of packaging material, were estimated at 119 and 46 days in OPP/MCPP and OPP/CPP sachets, respectively. According to these results, the quality changing of instant pasta measured during storage suggested that OPP/MCPP sachet had better protectively effect than the OPP/CPP sachet.

1. Introduction

Food packaging plays a vital role in maintaining the food's properties. If food is not packed in packaging, it may change both in physical and chemical properties, occurring the contamination in food. Moreover, Importantly, It may lead to taste changing and consumer will not be able to accept. Keeping food in a proper package will prolong the shelf life. For this reason, research and development of packaging are required to maintain food quality and extend the shelf life of food [1]. The shelf life of a food is defined by the time for which the product, stored under determined temperature conditions, presents alterations considered, up to a certain point, acceptable by the manufacturer, consumer and current food legislation. Many products show prolonged shelf lives, making their experimental determination difficult [2]. Although shelf life tests under the accelerated environmental condition represent an alternative, the accuracy of the shelf life evaluation also depends on the expertise of the sensory panelist. Using the critical moisture content, the shelf life of a dry food can be predicted. A model for shelf life prediction that is based on moisture content, permeability of the packaging material and storage temperature will be useful for identifying the quality storage life of food [3].

One of the company operating as a consumer goods would like to change the packaging of instant pasta from plastic cup made by polypropylene to be packing instant pasta in plastic bag first before packing another layer into the cup made from paper. Two types of plastic bags, which have the
different qualities of oxygen and moisture permeation, are brought to study about the packaging of instant pasta. The objectives of this study are to develop a prediction model for the shelf life of instant pasta based on moisture content and permeability of packaging material. Moreover, the results of these are brought to affirm by sensory test which can help to select the appropriate packaging.

2. Materials and methods

2.1. Sample preparation

Instant pasta, purchased from local market, was packaged in two different packaging materials i.e. type I OPP/MCPP sachet, made from orient polypropylene plastic film laminated with metalized cast polypropylene plastic film, and type II OPP/CPP sachet, made from orient polypropylene plastic film laminated with cast polypropylene plastic film. Samples of 22 g were taken in the sachet (8 cm*11 cm size) which were closed by heat sealing taking care that minimum possible air space remained in sachet. The sealing was carefully inspected to avoid any possibility of leakage. The sealed sachets were stored under accelerated condition (incubator that maintain temperature and humidity levels at 37°C, 85%RH) and inside a home refrigerator maintained at 4-10°C. The experiments were carried out for 12 weeks storage period at an interval of 1 week taking samples from each of the packaging and storage conditions. These samples were analyzed for multiple comparison sensory tests. Raw material characterization had been done by measuring moisture content (% d.b.), measured with moisture analyzer (Mettler Toledo HB43), and water activity, determined using a water activity meter (Aqua Lab Series 3).

2.2. Statistical analysis

The moisture content of instant pasta in sachet was analyzed by using MINITAB-18 statistical software. The factors, included in the ANOVA, were packaging material (OPP/MCPP and OPP/CPP), storage period and their interaction.

2.3. Sensory analysis

The method used for sensory testing is the multiple comparison test, which tasting instantly cooked pasta to find the difference between instant pasta that stored in accelerated condition and in low temperature condition. Three sensory specialists evaluated the instantly cooked pasta for overall, color, aroma and flavor acceptability on a 6-point hedonic scale. (1 = extreme difference, 2 = very much difference, 3 = distinctly difference, 4 = moderately difference, 5 = slightly difference, 6 = equal to standard). However, the regulation of acceptable minimum score by evaluated from average overall score was more than 2.

2.4. Moisture isotherm model

The GAB equation [4] was used to describe the dry basis moisture content ($X$) as a function of water activity ($a_w$):

$$X = \frac{X_0CKa_w}{(1-Ka_w)(1-Ka_w+CKa_w)}$$

where $C$ and $K$ are constants and $X_0$ is described in the literature as the monolayer moisture content on dry basis (kg/kg)

2.5. Measurement of permeability of packaging material

Five grams of dehydrated silica gel, packed in three OPP/MCPP sachets and three OPP/CPP sachets, were kept in the environment at 85%RH and 37°C. The weight of each package samples, determined by weighing the whole individual package using a laboratory level weighing balance having 0.0001 g accuracy, was measured at an interval of 24 h for 7 days and the respective weight gain was computed. The water vapor permeability, $k$ (kg/m² day Pa) of both the sachets was determined by using Eq.(2).

$$k = \frac{(Q/\tau)/A}{p}$$
where \(Q/t\) (kg/day) is slope of graph between weight gain of silica gel and time. \(A\) (m\(^2\)) is a surface area of the sachet that water vapor can penetrate. \(p\) (Pa) is saturation vapor pressure of water at 37°C.

2.6. Assessment of shelf-life of instant pasta

Shelf life [5] of instant pasta (\(\theta\)) was calculated using Eq.(3)

\[
\theta = \frac{W_s}{pkA} \int \frac{X_c}{RH-a_w} dX
\]

where \(W_s\) is initial weight of instant pasta. The moisture content (\(X\)) was considered as critical moisture content and corresponding water activity was calculated by fitting the GAB model (Eq.(1)).

3. Result

3.1 Sensory analysis

Average sensory scores of instant pasta packed in type I OPP/MCPP sachet and type II OPP/CPP sachet under accelerated conditions; overall, color, aroma and flavor acceptability, are given in Figure 1. Instant pasta packed in type I sachet was shown better score; overall, color, aroma and flavor than instant pasta packed in type II sachet. During 12 weeks, the overall score of instant pasta packed in type I sachet was more than 2 points which was within the acceptable range of consumers, and the overall score of pasta packed in type II sachet was 2 points, which was the limit of the range that consumers can accept. Therefore, the shelf life of instant pasta at the accelerated condition packed in type I sachet showed over 12 weeks and packed in type II sachet showed 12 weeks.

![Figure 1. Mean sensory score of instant pasta under different packaging condition](image-url)
Figure 2. Variation in moisture content of instant pasta packed in OPP/MCPP and OPP/CPP sachet under accelerated storage conditions

Table 1. Moisture content and water activity of instant pasta packed in OPP/MCPP and OPP/CPP sachet under accelerated storage conditions

| Storage period (weeks) | Type I pasta sachet (OPP/MCPP) | Type II pasta sachet (OPP/CPP) |
|------------------------|---------------------------------|---------------------------------|
|                        | Moisture content (g water / g dry pasta) | Water activity | Moisture content (g water / g dry pasta) | Water activity |
| 0                      | 0.0642 (0.0002) | 0.4053 (0.0081) | 0.0642 (0.0002) | 0.4053 (0.0081) |
| 1                      | 0.0706 (0.0002) | 0.4357 (0.0110) | 0.0690 (0.0006) | 0.4503 (0.0050) |
| 2                      | 0.0717 (0.0015) | 0.4497 (0.0096) | 0.0774 (0.0014) | 0.5023 (0.0067) |
| 3                      | 0.0722 (0.0016) | 0.4523 (0.0055) | 0.0815 (0.0005) | 0.5200 (0.0010) |
| 4                      | 0.0723 (0.0003) | 0.4530 (0.0096) | 0.0863 (0.0024) | 0.5380 (0.0027) |
| 5                      | 0.0735 (0.0010) | 0.4560 (0.0017) | 0.0904 (0.0034) | 0.5483 (0.0031) |
| 6                      | 0.0736 (0.0010) | 0.4617 (0.0038) | 0.0934 (0.0016) | 0.5600 (0.0080) |
| 7                      | 0.0745 (0.0008) | 0.4663 (0.0050) | 0.0938 (0.0009) | 0.5617 (0.0015) |
| 8                      | 0.0747 (0.0008) | 0.4703 (0.0148) | 0.0973 (0.0006) | 0.5723 (0.0038) |
| 9                      | 0.0762 (0.0009) | 0.4723 (0.0021) | 0.1008 (0.0023) | 0.5993 (0.0057) |
| 10                     | 0.0770 (0.0003) | 0.4763 (0.0080) | 0.1024 (0.0026) | 0.6097 (0.0035) |
| 11                     | 0.0778 (0.0015) | 0.4817 (0.0076) | 0.1038 (0.0020) | 0.6123 (0.0110) |
| 12                     | 0.0784 (0.0002) | 0.4847 (0.0012) | 0.1043 (0.0011) | 0.6160 (0.0010) |

3.2 Shelf-life of instant pasta

The variation in moisture content of instant pasta during accelerated storage is shown in Table 1 and Figure 2. There was a gradual increase in moisture content of samples in both OPP/MCPP and OPP/CPP packages. ANOVA, for moisture content, indicated that the type of packaging material, and storage period, significantly affected (p ≤ 0.05) the moisture gain of instant pasta. The moisture gain by instant pasta packed in the OPP/CPP was more than the OPP/MCPP sachet. Moisture content after 3 months of storage, was 10.43% and 7.84% (d.b.), respectively for samples packed in OPP/CPP and OPP/MCPP.

An isotherm graph of instant pasta is presented in Figure 3. The constant in GAB model; $C$, $K$, and $X_0$, was calculated by fitting the GAB model (second order polynomial regression) between moisture content ($X$) and water activity ($a_w$). The GAB model (Eq.(1)) showed the regression coefficient ($R^2$) = 0.9998 which can be considered as a good fit with experimental data. The $C$, $K$, and $X_0$ are 3.6006, 0.8051 and 0.0677, respectively.
Figure 3. GAB model between water activity and moisture content of instant pasta.

The cumulative moisture gain of silica gel with time in OPP/MCPP and OPP/CPP sachets at 37°C and 85%RH was used to fit straight line. By inserting the slope of the straight line (Q/t), the surface area of the sachet (A) = 0.0176 m$^2$ and the saturation vapor pressure of water (p) at 37°C = 6275.47 Pa, into Eq.(2), the water vapor permeability (k) of OPP/MCPP and OPP/CPP are 1.34 × 10$^{-7}$ and 3.44 × 10$^{-7}$ kg/(m$^2$ day Pa), respectively.

Water activity and moisture content are the most valuable characteristics for assessing the stability of dried foods. Increasing of the moisture content during storage causes the product to become damaged. Requirements for storing dry food, water activity of instant pasta is set to not excess 0.55. In this research, the initial moisture content of instant pasta was 6.24%.

The critical moisture content, corresponding with water activity of 0.55, calculated by the GAB model, is 0.090. The shelf-life of instant pasta in OPP/MCPP and OPP/CPP sachets, estimated by Eq.(3), were calculated as approximate 119 and 46 days, respectively.

4. Conclusions

Comparing shelf life of instant pasta packed in type I and type II pasta sachet, type I pasta sachet was made from orient polypropylene plastic film laminated with metalized cast polypropylene plastic film (OPP/MCPP) and type II sachet was made from orient polypropylene plastic film laminated with cast polypropylene plastic film (OPP/CPP), at accelerated condition. The shelf life, predicted from sensory tests and model for the shelf life based on moisture content and permeability of packaging material, revealed in the same way. As a result of, OPP/MCPP sachet had better protectively effect than OPP/CPP sachet.

5. References

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