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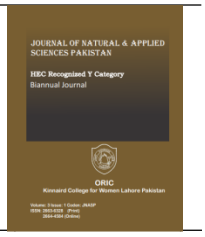

SHELF-LIFE ESTIMATION OF MEAL-REPLACEMENT BARS BY SENSORY EVALUATION

Sana Farooq[1*], Mahnaz Nasir Khan[1], Zunaira Maqsood[1]
[1]University Institute of Diet and Nutritional Sciences (UIDNS), The University of Lahore, 1-km Defence Road, Lahore, Pakistan

Article Info

*Corresponding Author
Email: sana.farooq240@gmail.com

Abstract

Shelf-life can be estimated by sensory evaluation as the food changes its sensory attributes when it goes through the spoilage phase. This study was undertaken to estimate the shelf-life of previously developed meal-replacement bars by sensory evaluation procedure. The expert panel in this study assessed the bars to estimate the shelf-life with the change in any sensory attributes. A 5-point hedonic scale was used for scoring the sensory attributes, and the mean score of each attribute was calculated for the assessment of any change. Aluminum foil, butter paper, and cling film were assessed as packaging material for the bars on three parameters. The results estimated that the shelf-life of the bars was 13 weeks from the date of production. It was examined by comparing the change in taste and softness of the developed bars by evaluating the mean scores. In addition, aluminum foil was assessed to be the most desirable packaging material as it enhanced the shelf-life. Sensory attributes evaluation was effectively applicable for the bars' shelf-life evaluation. The product's sensory characteristics alter if there is any kind of microbial activity or the product is not fresh to any further extent. Shelf-life estimation by sensory evaluation is an effective parameter to evaluate any food product. This study will open a window and support for more research studies on evaluating and estimating the shelf- life of various foods by assessing alterations in sensory attributes of the respective food.

Keywords
Shelf-Life, Sensory Evaluation, Meal-Replacement, Hedonic Scale, Meal-Replacement Bars

1. Introduction

Sensory evaluation is a technical aspect that arouses the senses in mind to evaluate the product, then understand and explain the characteristics that a specific product governs within. The use of five senses does it, i.e., sight, touch, hear, smell, and taste. These five human senses evaluate the product through the sensory attributes and characteristics of the product (Stone & Sidel, 1993). Sensory evaluation is

being used as the parameter for estimating the shelf-life of food products in past years. Sensory evaluation by sensory analysts to estimate the product's shelf-life has been vital for quality evaluation, storage, developmental, and enhancement procedures (Dethmers, 1979). The principle of shelf-life is to define the duration of the product's storage, to be safe for consumption in its original best quality (Silva *et al.*, 2013). It included the systems for precise assessment of responses by humans to food. It lessened the possible biases of consumer views, which are affected by the impact of different brand names of the product or other statistics given by other means (Heymann & Lawless, 1999).

The food should have more shelf-life to avoid spoilage during long-duration missions, should be palatable and ready for consumption. Apart from this, it should also be sufficient in nutritional aspects (Dye, 1964). Furthermore, for the shelf-life estimation, changes in sensory characteristics by the color change of cut apples were assessed, as the sensory evaluation is a good sign of quality fruits (Rocha & Morais, 2003). Likewise, in a study, the shelf-life of oranges was estimated by microbial and sensory evaluation. The microbial growth evaluation estimated the shelf-life of oranges as 15 days, while sensory attributes quality evaluation was estimated to be about five days (Rocha *et al*., 1995). In another study, the appearance, tenderness, and juiciness of fish were assessed to estimate the shelf-life by the treatment and storage of fish in different chemical solutions (Sallam, 2007).

In the present study, the shelf-life of the meal-replacement energy bars, developed previously, were assessed based on the alteration in any of the sensory attributes during a period. This evaluation method was effective, as there is always a change in the sensory characteristics of food when it goes through the spoilage phase or has any microbial activity.

2. Methodology

2.1 Conceptual Framework

The stepwise methodology was followed according to the conceptual framework (Figure 1).

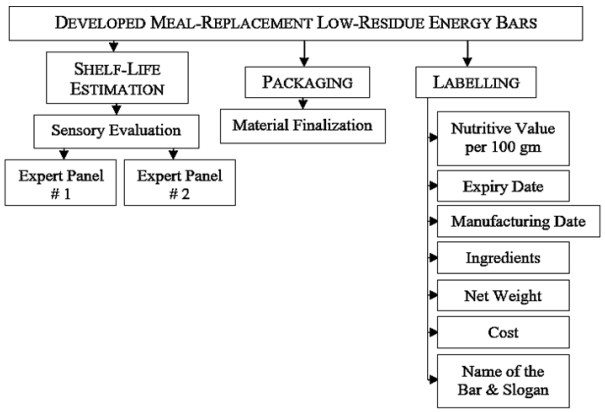

Figure 1: The Conceptual Framework for the Shelf-Life Evaluation of Meal-Replacement Bars

2.2 Study Design

An experimental study design was used to estimate the shelf-life of the bars by sensory evaluation.

2.3 Shelf-life Estimation by Sensory Attributes Evaluation

The sensory evaluation had been used as the parameter for estimating the shelf-life of food products for many past years. Shelf-life

estimation was carried out by observing the change in sensory characteristics in food products. In different studies during past years, sensory attributes as taste and color of apples, mangoes, fish, lettuce leaves were assessed for shelf-life estimation and quality evaluation. Hence, evaluation by the sensory attributes had been said to be a good sign of the quality of the food products (Rocha & Morais, 2003; Chiena *et al*., 2007; Rocha *et al*., 1995; Aresa *et al*., 2008).

2.3.1 Sensory Attributes

Softness, color, taste, aroma, and overall palatability were listed as sensory attributes for evaluating the bars.

2.3.2 Evaluation Scale

A 5-point hedonic scale was utilized for the evaluation purpose. The scale ranged from score 5 (like extremely) to 1 (dislike extremely). The mean scores were taken for final scores.

2.3.3 Panel Of Judges

The expert panel was selected for the sensory evaluation of the bars.

In the current study, the samples of three bars wrapped in aluminium foil were kept at room temperature (35^{O}C to 44^{O}C) for 13 weeks. Followed by this, they were analyzed by the difference in sensory characteristics of the bars and evaluated by the expert panel using a 5-point hedonic scale for sensory attributes.

2.4 Packaging And Labeling Of The Bars

Aluminium foil, butter paper, and cling film were judged for the packaging of the bars. The bars were wrapped and kept at room temperature. Later on, were assessed for the best packaging material. Criteria for assessment used were:

- Moisture vapors on the inner surface of the material
- Bars become dry and hard
- Inclusion of outside aroma in the bars

Labeling of the bars was done according to the Food and Drug Administration (FDA) components of labeling (Food Packaging Labels, 2015) and by including some more important aspects to be mentioned in the label. The label and company of the product studied have not been registered yet. The label designed in this study included the name of the bar, slogan, nutritive value per 100-gram bar, expiry date, manufacturing date, list of ingredients, net weight as 225 grams of one bar, price, storage conditions, food colors, artificial flavors, contact and company information.

3. Results

3.1 Shelf-Life Estimation By Sensory Attributes Evaluation

The shelf-life of the bars was estimated by comparing the results of sensory analysis. The bars were prepared on the same day of evaluation and then were kept wrapped in aluminum foil at room temperature (35OC to 44OC). They were evaluated after 13 weeks for any alteration in sensory characteristics by the expert panel using the 5-point hedonic scale for sensory attributes.

3.1.1 Comparative Sensory Evaluation of Fresh Bars and other Bars after 13 Weeks

The mean scores of the likeness of bars in figures 2, 3, 4, and 5 represent that the bars did not become stale, but the evaluation of the softness and taste shows that they were changed after 13 weeks. The color, aroma, and overall palatability of the bars remained the same. This concluded that the bars did not expire for consumption, but it was better to consume bars before 13 weeks prior to becoming harder (Table 1, Figure 2).

Comparative Sensory Evaluation of Fresh Bars and Bars after 13 Weeks

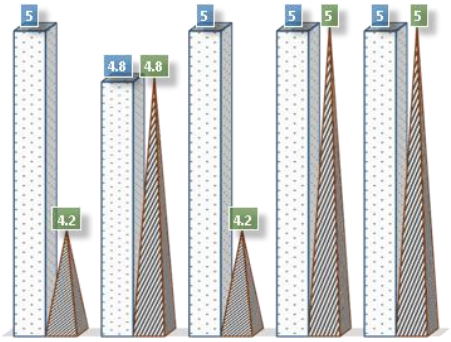

Figure 2: Sensory Evaluation Comparison For Shelf-Life Estimation

3.1 Packaging of the Product

Table 2 showed that aluminum foil was the best and most desirable material for packaging for the product, as it enhanced the shelf-life of the bars. It retained the desired taste and smell by not letting outside aroma from entering the bars; and desired texture by preventing it from becoming hard and dry. The aluminium foil also had no moisture vapors on the foils inside surface, which aided in improving the shelf-life by reducing the bacterial or fungal growth due to the moisture.

Table 1: Mean Scores of Sensory Evaluation for Shelf-Life Estimation

	Softness	**Color**	**Taste**	**Aroma**	**Overall Palatability**
Likeness of Fresh Bars	5	4.8	5	5	5
Likeness of Bars After 13 Days	4.2	4.8	4.2	5	5

Table 2: Assessment of Packaging Materials

No.	Criteria for Assessment	Aluminium Foil	Butter Paper	Cling Film
1	Moisture vapors on the inner surface of the material	✗	✗	✓
2	Bars become dry and hard	✗	✓	✗
3	Inclusion of outside aroma in the bars	✗	✓	✗

4. Discussion

In a previous study, the foods stable microbiologically were observed to have some degree of alterations in sensory attributes; as the changes occur in flavor, texture, and appearance due to physicochemical changes in the food (Kilcast, 2000). Likewise, the sensory evaluation had been used to assess food products' sensory attributes (Stone & Sidel, 1993). In this study, shelf-life estimation was done by the sensory evaluation of different parameters and sensory characteristics of the bars including softness, color, taste, aroma and overall acceptability.

In a study, the quality and shelf-life of mangoes were evaluated by assessing the sensory modifications in the color and taste of fruit, and the loss of water after coating it with a layer of edible chitosan, to increase its shelf life (Chiena *et al.,* 2007). Furthermore, slightly processed lettuce leaves were sensory evaluated by two panels (expert sensory panel and consumer panel) to conclude failure criteria built based on rejection by the consumers to purchase the lettuce (Aresa *et al*., 2008). Moreover, a study was conducted to evaluate the shelf-life of food products. Sensory evaluation scales were used for estimating the endpoint of failure. Over time, when the same product was evaluated not suitable for consumption anymore, it was said to be the time of failure, representing the endpoint of shelf-life (Gacula & Kubala, 1975).

Similarly, in another study, the same criteria of failure of the food product by sensory evaluation parameters were used for the quality assessment for the shelf-life estimation (Gacula, 1975). Sensory evaluation for estimation of quality deterioration and shelf-life-interval of cooked fish by Torry scheme and raw fish by Quality Index Method Specific was done (Šimat *et al*., 2012). Furthermore, sensory features of orange juice were assessed for shelf-life evaluation after using two different methods of pasteurization. Stability in color, flavor, odor, acidity, sweetness and overall acceptability by the expert panel by means of a hedonic scale was done (Walkling-Ribeiro *et al*., 2009). Additionally, in another study, sensory evaluation of milk powder for its shelf-life was done by a hedonic scale. The comparison and correlation between the skilled expert panel evaluation of the product and the consumer panel evaluation of the same product were

evaluated (Hough *et al*., 2002).

The hedonic scale had been used for sensory evaluation since the 1940s (Lawless & Heymann, 1999) on the criteria of consumer's likes and dislikes for the preferences of food products, as it had been effortless for implementation and easy to be followed by the evaluators (Moskowitz *et al.,* 2003). In the present study, the hedonic scale was used for the shelf-life evaluation purpose by the sensory characteristics of the bars. A 5-point hedonic scale had been said to be the compact form of a 9-point hedonic scale, as the consumers and evaluators have a preference for fewer categories for the product evaluation (Moskowitz *et al.,* 2003). In a study, different hedonic scales including a 5-point hedonic scale was used by the children of age 36-71 years to sensory evaluate the color, taste and mouth-feel of the milk (Chen *et al.,* 1996). Furthermore, a 5-point hedonic scale was used to evaluate sensory attributes of two types of roasted peanuts. The appearance, color, taste, flavor and texture were assessed and the scale was classified as ranging from 1-dislike it very much to 5-like it very much (Nepote *et al*., 2008). Conclusively, the sensory characteristics of the product alters if there is any kind of microbial activity or the product is not fresh. Hence, sensory evaluation by a 5-point hedonic scale is effectively applicable for the product's evaluation, consumer acceptability and also shelf-life assessment of the developed food products.

The aluminum foil was assessed to be the best and desirable material for packaging purposes in this study. It maintained the desirable texture of the bars by preventing bars from drying and becoming hard. It also had no moisture vapors on the foil's inside surface, which aided in enhancing the shelf-life by minimizing bacterial or fungal growth due to moisture. Likewise, another study showed that aluminium foil prevented moisture, environmental smell and gasses like oxygen from passing through it. Therefore, it serves as a protective wall for enhancing the shelf-life of the product (Lamberti & Escher, 2007).

5. Conclusion

Altered sensory attributes had always been affected by the microbiological changes in the food products; therefore, the shelf-life can be estimated by the sensory evaluation. Shelf-life estimation of meal-replacement bars was done in this study by the sensory evaluation. The expert panel scored sensory attributes on a 5-point hedonic scale. The results estimated that the shelf-life of the bars was 13 weeks from the date of production by noticing the alterations in taste and softness of the developed bars by the mean scores. Later on, the aluminium foil, butter paper and cling film were assessed as a packaging material for the bars on three parameters. The aluminium foil was assessed to be the best and the most desirable packaging material as it enhanced the shelf-life by meeting the criteria for assessment. Sensory evaluation was

effectively applicable for the shelf-life evaluation as it can be judged by even a minor variation in any of the sensory characteristics.

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