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Unwrapped food product display shelf life assessment

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Abstract

Chilled foods have been available since the 1960s. However, over the past 20 years, the market has been driven by the huge social, economic and demographic changes that have influenced our eating habits. This has contributed to making the chilled food production and retail in the UK one of the world's fastest-growing food sectors with food retail stores, restaurants and cafeterias. One very important fixture in these commercial establishments is the display cabinet where food is chilled and displayed. Many guidelines & regulations exist regarding displaying of food in cabinets. Amongst these are ones that relate to food deterioration such as the Food Hygiene Regulations 1995 (updated in January 2006), which related specifically to the retail sale and distribution of chilled foods. The most important point of these regulations was a requirement for sensitive foodstuffs to be maintaining at 8°C or below (Part II). These regulations were focused on reducing the risk of bacterial spoilage associated with chilled foods. The Regulations did not engage in the deterioration problems associated with moisture transfer and evaporating loss of unwrapped chilled foods displayed in delicatessen cabinets. This paper present result from theoretical and experimental investigation into the display shelf life in terms of bacterial spoilage and weight loss for some unwrapped sandwiches components including vegetables, tuna, cheese and beef. The output of this work showed that the display shelf life in terms of weight loss is shorter compared to the shelf life in terms of bacterial spoilage and it's related to food drying rate. Surface drying, increases the weight loss and leads to colour changes that are undesirable and results in shorter display shelf life. Weight loss was affected by air relative humidity, velocity and temperature. Therefore, more consideration should be given to environmental boundary conditions, which have direct impact on the quality and shelf life of unwrapped product.

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Keywords: Unwrapped Chilled Food; Display Shelf Life; Drying Rate; Weight Loss; Bacterial Spoilage.

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1. Introduction

Shelf life represents the useful storage life of food, which is determined by changes in taste, smell, texture, or appearance that are considered to be unacceptable or undesirable. The underlying causes of these changes may be microbiological, chemical or physical. Different types of spoilage are associated with chilled delicatessen food, such as Abiotic spoilage, which is caused by chemical and physical changes in the product, and Biodeterioration spoilage that is caused by bacteria, yeast and mould. Surface drying has been identified as the main reason for commercial loss from unwrapped chilled food in display cabinets [1]. Weight loss has also been identified as the most important cause for the end of display shelf life of meat, fish and their products [2]. It was found by [3] that discoloration is the most important limiting factor controlling the display shelf life of pre-packed meat and a relationship was established between weight loss during display and colour changes. Many investigations have been carried out to establish the variation of drying rate as a function of the environmental boundary conditions. Some of these investigations were experimental and involved mainly meat and meat products and resulted in recommendations for increasing product shelf life and minimizing weight loss [4-5]. Other investigations attempted to develop mathematical models to calculate the drying rate as a function of the environmental conditions and product variables such as shape and water activity [6- 7]

The presence and growth of bacteria often determine the quality and shelf life of foods. Monitoring the sensory quality of the food product and the growth of spoilage microorganisms can be used to develop a mathematical model to determine the shelf life of a food product based on the growth of a specific microorganism.

Spoilage due to bacteria growth is most rapid in proteinaceous foods such as meat, poultry, fish and some dairy products. These foods are highly nutritious, possess a neutral or slightly acidic *pH* and high moisture content and therefore permit growth of a wide range of bacteria. Changing the storage conditions is the only way to delay spoilage and provide longer shelf life for these types of food.

Unwrapped food products such as sandwiches are one of the most popular fast foods in the UK. The classic baguette sandwich consists of a baguette with different fillings in the middle, such as meat, fish, egg, cheese and vegetables. Sandwiches available in local shops are mostly made fresh on the day. It was reported by [8] that meat sandwiches occupy around 31.1 % of the total sandwich market, followed by fish 22.2%, cheese 17.7% and egg 8.8%. For this reason beef, vegetables (Lettuce, tomato, cucumber, pepper), cheese and tuna were considered in this study. Moreover this study is interested in refrigerated display conditions such as temperature, relative humidity and air velocity.

2. The Mechanism of Bacterial Spoilage and the Specific Spoilage Organism (SSO)

Bacteria, mould and yeast cause Biodeterioration spoilage. Bacteria are very simple forms of plant life. Under ideal conditions, bacteria can grow and reproduce at high rate in some cases, in as little as 20 minutes [9]. Bacterial growth is influenced by many factors, such as Intrinsic factors (e.g. *pH*, water activity), Extrinsic factors (e.g. refrigeration, modified atmosphere packaging) and Implicit factors (e.g. specific growth rate of the micro-organisms and microbial interactions) [10]. Bacterial growth on food changes as it passes through a succession of stages. Microbiologists, base bacteria counting on the assumption that one single bacterium can give rise to one colony on solid media. Each colony is referred to as a Colony Forming Unit (*cfu*) for short.

Evaluation of the maximum number of spoilage microorganism cells at the point when the food product reaches the final stage of its life can be used as indicator of the food product shelf life. Therefore the shelf life of specific food product in terms of bacterial spoilage can be defined as the time required by the spoilage microorganism to reach maximum density of cells. The number of bacteria cells will start to increase at the beginning of the growth phase, but before that happens some time is required to prepare for the growth (Lag phase). Therefore, the shelf life basically represents the lag phase time and the time required by the bacterium during the growth rate to reach maximum density. Almost all groups of microorganisms under some conditions can contribute to spoilage of foods. It was suggested by [11] that predictive models for spoilage should be developed only after knowing the microorganism responsible for the reactions that are important in the process of spoilage and the range of environmental conditions under which these organisms cause spoilage. Authors of [12] emphasised that spoilage models based on the responses of the dominant organism are valid only in the specific range of conditions. Out of