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EFFECT OF ATMOSPHERIC CONTAMINATION IN THE APPLICATION OF PIGMENTS IN THE FOOD INDUSTRY OF MEXICALI

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ABSTRACT: *The use of pigments in the food industry has been of great importance in the last thirty years, to obtain better benefits in the process of commercialization of food products. The pigments are developed for a large amount of food, based on characteristics of the application methods. In addition, climatic conditions are considered in the storage and manufacturing processes, as well as the types of food and packaging that identify them. This is done with the aim of obtaining a good appearance, and being an attractive product for food consumers. Sometimes the pigments do not have good adherence and based on that, a study is carried out on pigments that lost their coloring properties quickly, as well as the foods in which they adhered. Correlations of air pollution were developed, observing the effect of relative humidity (RH) levels and temperatures higher than 80% and 40 °C in the summer season, mainly in the months of July and August in the city of Mexicali. Food with defective levels of pigmentation must have been returned to manufacturing processes or be offered as food for pigs at a much lower cost than commercialized, causing economic losses for the company. The descriptive analysis was with the Scanning Electronic Microscopy (SEM) technique.*

KEYWORDS: Air pollution, pigments, food industry, MBE

INTRODUCTION

The visual aspect of the final product that represents one of the factors of food quality is sometimes altered by air pollution, being generated by air pollutants mainly by sulfides in the city of Mexicali. In addition to these chemical agents that modify the nutritional properties of the pigments that are added to food products in this region of the Mexican Republic considered as an arid zone, the variations of climatic factors such as humidity and temperature are annexed. Due to the fact that in a food company in the city of Mexicali, there were low quality situations in foods, sometimes a certain type of artificial pigments were very sensitive to light, acidity and heat, [1] and an investigation was carried out. To know the causes of their disintegration in the process of adhesion to food as sweet coatings.

Food industry

Food processing is the methods and techniques used to transform raw materials into food for human consumption, having clean, harvested or slaughtered and killed components and using them to produce commercial products of food products. There is a great variety of different ways in which food can be produced. The realization of one of food products could take days depending on the specifications of the client for the design and conditions of the capacity of the

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industrial plant that performs it [2]. Online production is used when the size of the market is large and where there is a range within a selection of products. A certain number of the same goods to be produced, require simple and complex methods in the manufacturing processes. All the methods consist of estimating the number of customers who wish to buy that food product. Mass production is used when there is a mass market for a large number of identical products, for example, chocolate bars, ready meals and canned foods. The product passes from one production stage to another along a production line. All the components of this product are specified by the customer, who chooses them based on their structure, taste, smell and other characteristics of the food. An extensive global transport network is required by the food industry in order to market its numerous products. These include suppliers, manufacturers, warehouses, retailers and final consumers. There are also companies that add vitamins, minerals, and other necessary requirements during the process to recover the losses during the preparation [3]. Wholesale markets for fresh food products have tended to decrease in importance in Latin American countries and some Asian countries as a result of the expansion of supermarkets, which they acquire directly from farmers through preferred suppliers, instead of going to through the markets. The constant and uninterrupted flow of products from distribution centers to store locations is a critical link in the operations of the food industry. Distribution centers operate more efficiently, you can increase performance, you can reduce costs and take advantage of better labor if you have the right steps when you set up a material handling system in a warehouse. With populations around the world to concentrate in urban areas, the purchase of food is increasing and is required according to the nutritional processes, always evaluating the aspects of food production. This is a relatively recent development, which has taken place mainly in the last 50 years [4]. The supermarket is the defining element of sale of the food industry, where tens of thousands of products are gathered in one place, continuously throughout the year of supply. Restaurants, coffee shops, bakeries and mobile trucks are also ways to reach food consumers. Food preparation is another area where the change in recent decades has been spectacular. The food industry sells fresh and raw products largely to consumers, and they use the necessary ingredients for their production. One of these ingredients are the color pigments for their best presentation.

Stages of a food industry

The food industry uses a variety of processes in the manufacture of food products with high technology in their production processes. This is done with the objective of preparing with the best conditions of customer satisfaction, hygiene and with the lowest costs, with all types of food processing technologies. The main stages in the manufacture of food are [5]:

a) Use of technologies for the supervision and storage of food as raw material for processing.

b) Evaluation of the types of ingredients for the conservation of food in the company and outside it.

c) The use of simple and complex methods in the processing of food according to specific conditions generated by the customer.

d) Supervision of the quality of the final product with specialized methods and techniques that meet the needs of consumers.

e) Storage of final products in specific areas with high levels of security.

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f) Analysis of the treatment of food residues or chemical substances used in the process for the manufacture of food products.

Food dyes

Food colorants, or color additives, are any coloring pigment, or substance that imparts color when added to food or beverages. They come in many forms that consist of liquids, powders, gels and pastes. Food dyes are used both in the commercial production of food and in the domestic kitchen. For their safety and general availability, dyes are also used in a variety of non-food applications including cosmetics, pharmaceuticals, craft projects and medical devices [6]. People associate certain colors with certain flavors, and the color of the foods can influence the perceived taste in any aspect. Sometimes, the goal is to simulate a color that is perceived by the consumer as natural, such as the addition of red dyes to candied cherries (which would otherwise be light brown in color), but sometimes it is for the appearance effect , like ketchup Heinz green ketchup that launched in 1999. Coloring additives are used in foods for many reasons, including [7]:

a) To compensate for the loss of color due to exposure to light, air, extreme temperatures, humidity and storage conditions.
b) Correct natural color variations improve the colors that occur naturally, to provide colors to a variety of colorless substances and foods that look good.

Color additives are recognized as an important part of many foods we eat. The dyes for the food industry are the safety test by various organisms around the world and sometimes different bodies have different views on food safety in color [8]. In the United States, the levels of safety regulated by the FDA (Food and Drug Administration), indicate that they can be used in food, drugs and cosmetics, mainly, being approved as synthetic food dyes that do not exist in nature, while in The European Union uses them as for all additives, both synthetic and natural, that are approved in food applications. The best-known food dyes are turmeric and lutein. Most other countries have their own regulations and list of food dyes that can be used in various applications, including maximum daily intake limits [9]. Certified colors are synthetically produced and widely used, as they impart an intense, uniform color, are less expensive, and blend more easily to create a variety of shades. There are nine main types of coloring additives certified and approved for use in the United States. Certified colors in food generally do not provide undesirable flavors to food and are exempt from certification including pigments derived from natural sources such as vegetables, minerals or animals. Natural additives derived from colors are generally more expensive than certified colors and can add unwanted flavors to food. The main examples of exempt colors include achiote, beet extract, caramel, beta-carotene and grape skin extract. The natural colors of foods can make a variety of different shades [10]. An increasing number of natural food dyes are being produced commercially, in part due to the concerns of consumers surrounding synthetic dyes. Some examples include [11]: the caramel, made with caramelized sugar, achiote, a reddish-orange coloring from the annatto seed, chlorophyllin, a green coloring made from algae, the chlorella cochineal, a red dye derived from the insect cochineal dactylopius coccus betanin, extracted from the turmeric beet (curcuminoids), the saffron from the carotenoids, the paprika, lycopene, elder pandan juice (pandanus amaryllifolius), which is a green pea butterfly dye (clitoria ternatea), being a blue food dye. To

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ensure reproducibility, the colored components of these substances are often provided in highly purified form, and to increase stability and convenience, they can be formulated into suitable support materials (solids and liquids). Solvents hexane, acetone and others break the cell walls of fruits and vegetables and allow maximum extraction of the dye. The residues of these often remain in the finished product, but do not need to be declared on the product, this is because they are part of a group of substances known as baggage over ingredients. The colors of natural foods, due to their organic nature, can sometimes cause allergic reactions and anaphylactic shock in sensitive people. The coloring agents are known to have potential hazards including achiote, cochineal and carmine [12].

Effects of atmospheric pollution on the properties of pigments

The presence of pollutants in the atmosphere is of great concern because its effect combined with variations in humidity and temperature, at certain times of the year, generate corrosion and with it changes in the properties of pigments used in food products. These properties cause poor appearance in food, even when packed and packaged by the discoloration process [13, 14]. Despite the requirement of compliance with the quality standards of manufacturing and environmental food products, they were still presented with energetic protection systems, certain types of pollutants in the interior of the industry where the study was conducted. There are several types of sources that emit these elements in the atmosphere, being mainly in the city of Mexicali, sulfides by car emissions and the main source of geothermal energy. This electric station supplies electricity to the city, Mexicali valley, San Luis Rio Colorado, Sonora and some cities of the United States located on the border with Mexico, in this region of the Mexican Republic. The levels higher than 70% of RH and 30 ° C of temperature, modified the properties of the pigments used for food products, generating that sometimes the pigment did not adhere properly to the surface of a wheat flour food. Sometimes the pigment was dropped or in the processes of marketing and transportation, the external structure of the food product was modified and it caused a bad appearance, being returned to the company that manufactured it, generating economic losses as shown in figure 1a and 1b. As shown in the following figure, the dark sections are parts of pigment not adhered properly that generated effective food products and with it the economic losses because it is necessary to commercialize them to pig activities at a lower price than the population consumer.

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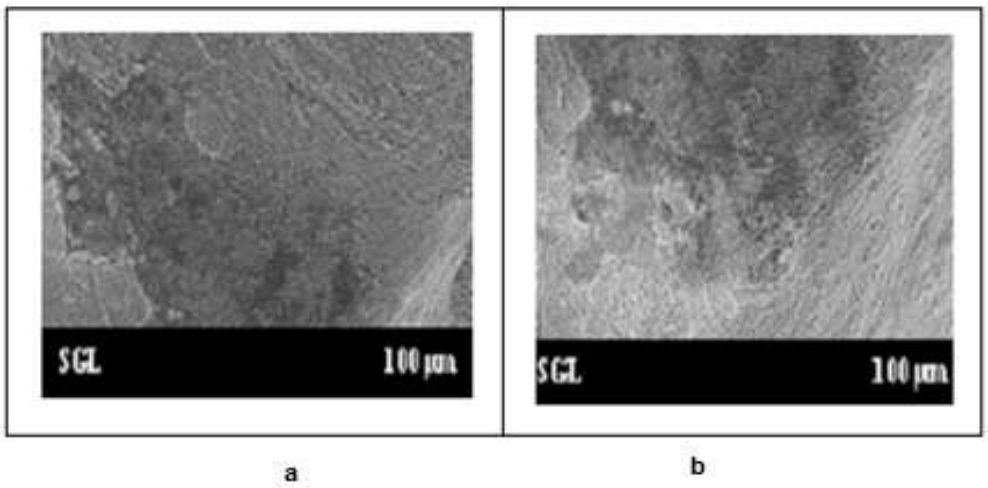

Figure 1. Microanalysis of food surfaces evaluated with detachment of the additive as pigment generating bad appearance in the industrial plant in Mexicali (2011) at 100X.

METHODOLOGY

The research was developed in a company that manufactures food products of flour, being correlated both the failures of the defective products with the climatic factors mentioned above and aspects of climate more important. The manufacturing processes of the industrial plant where the study was carried out were evaluated every month, as well as the indexes of each month and time of year of HR and temperature. Other factors evaluated were the physicochemical surface properties of the pigments used in this type of food with the MBE technique. In each monthly analysis, 100 food products were evaluated in the period from 2010 to 2011. The correlation was made with the MatLab program.

RESULTS

The pollutants transported by the air in gaseous and solid state comprise small dust particles of hydrogen sulfide (H_2S), sulfur dioxide (SO_2) and nitrogen oxides (NO_X), mainly which are able to penetrate the interior areas of industrial plants. These chemical agents that generated aggressive environments inside the evaluated company, penetrated through the air inlets of the filtering systems, holes and slits. In combination with humidity and temperature, they produced damage to the manufactured food. The difference of a food in good condition and a food with sections of the pigment not adhered is shown in Figure 2.

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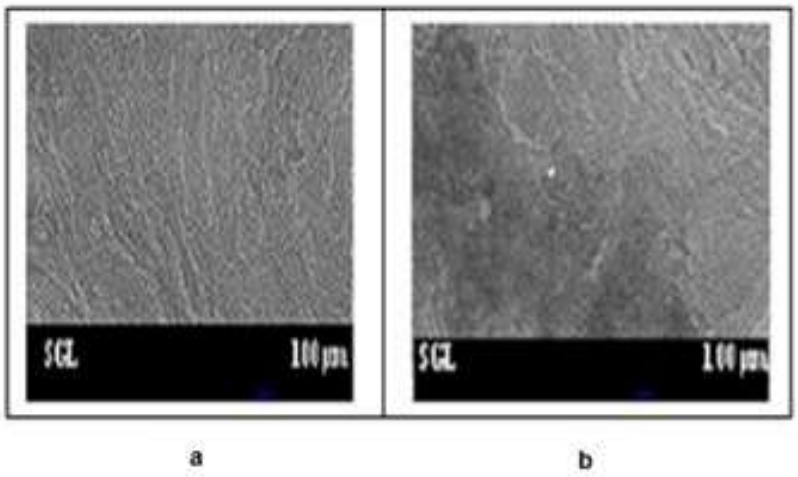

Figure 2. Microanalysis of food surfaces in: (a) good condition and (b) deteriorated in the interior of an industrial plant in Mexicali (2011) 100 X.

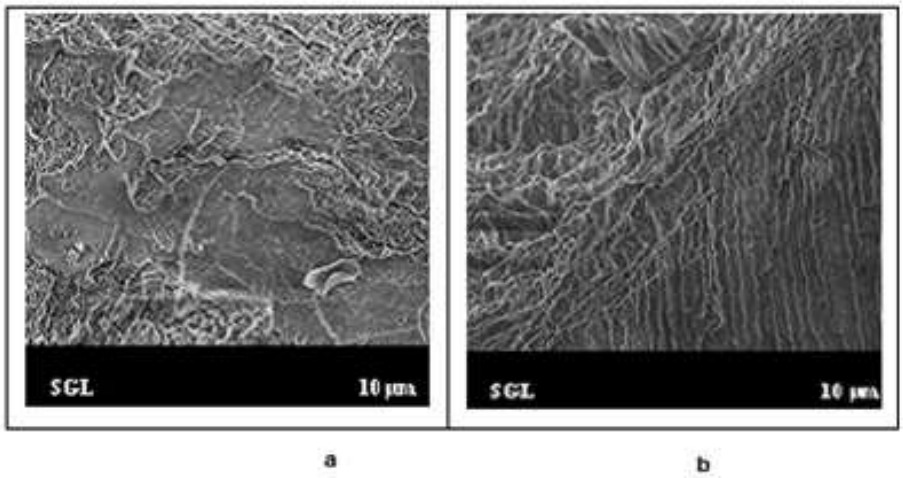

Figure 3. Microanalysis of deteriorated food surfaces at the time of: (a) summer and (b) winter in the interior of an industrial plant in Mexicali (2011) 10 X.

Figure 3 represents a microanalysis of the appearances of the food product with deficiencies in the adhesion of the pigments in the summer and winter seasons. In the summer season, deterioration by sections of a piece of a food is observed and in winter, uniform deterioration is indicated in some areas of the food product.

Correlation of air pollution with the deterioration of pigments

The properties of the pigments vary according to the variations of RH and temperature being indicated by the levels of colors in figures 4 and 5. The red color indicates the high levels of losing the discoloration, followed by the yellow color in intensity of losing its properties, then

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the light blue color and ending with the dark blue. All the levels are derived from the correlation of the HR and temperature levels with pigment coloration indexes and the ranges in which humidity can have a negative effect and to take the necessary measures can be observed. Various pigments were analyzed, such as caramel, achiote and chlorophyllin, and saffron, since they were used by the company where the study was conducted. In the winter season there are more risks than in the summer, this does not mean that pigments are quickly discolored, but rather a simulation indicating the possibility of the event happening.

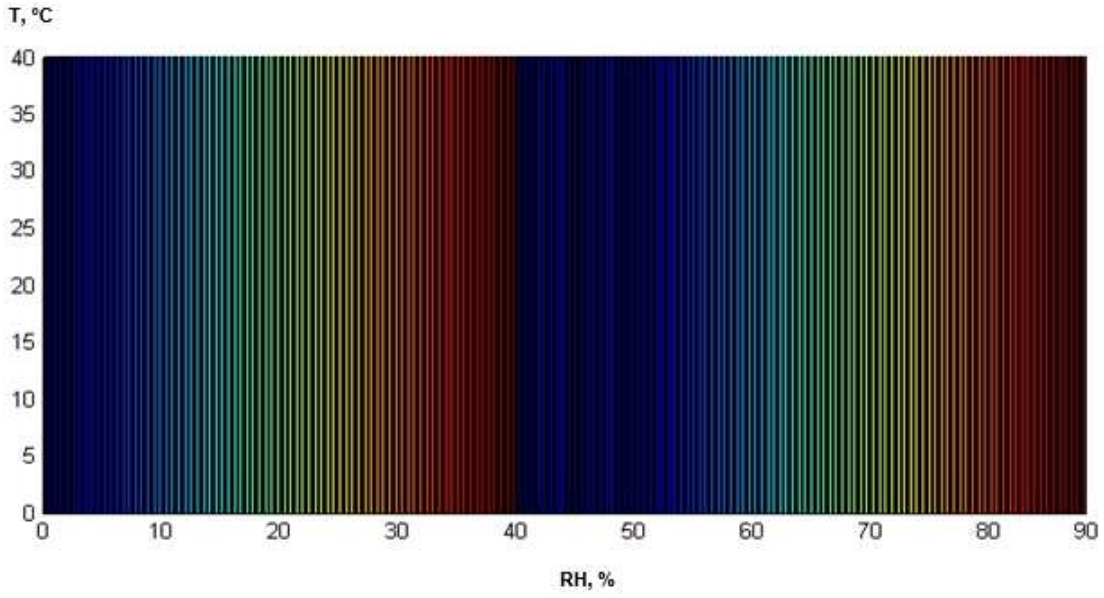

Figure 4. Correlation of the HR and temperature with indices of coloration of achiote pigment with an analysis in the interior of an industrial plant in summer in Mexicali (2011).

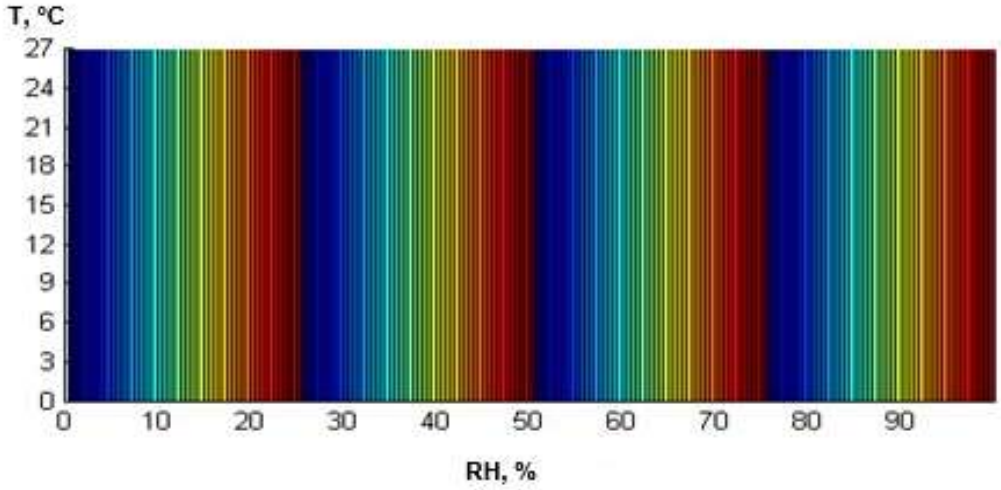

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Figure 5. Correlation of the HR and temperature with indices of coloration of achiote pigment with an analysis inside an industrial plant in winter in Mexicali (2011).

CONCLUSIONS

Corrosion is the general cause of the destruction of most of the materials used in the food industry. The development of corrosion processes in the materials used to manufacture food products, leads to modify their properties that subsequently have an adverse effect on the manufacturing processes, especially in the case of the study conducted in the company that allowed us to investigate what happened with the foods that they commercialized. The pigments used as additives to the evaluated foods are of great importance to generate a good appearance in the food products that support the fast and easy commercialization in the region, before beginning to observe some changes in the coatings of these. Humidity was the factor that had a greater effect in this process and a moisture control system was recommended that has already been tested in other companies. The temperature had an effect to a lesser degree, but it is important to consider it because if the humidity varies, the temperature characteristics change.

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