Effect of Packaging Shape and Storage on the Keeping Quality of Mineral Water and a Development of Water-Treatment Device

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Abstract

A notable change of quality and increase in the cost of water-treatment devices has resulted from the current water-treatment and packaging techniques in the food industry. Because of these factors, efforts to discover alternative, less stringent packaging techniques have taken a place of high priority in food science. Pyramidal food packages are capable of altering the crystallization mode of water’s mineral content. The effects of pyramidal and square packaging shapes on mineral water were studied by examining ice surface morphology. Ice surface morphology was examined by variable pressure scanning electron microscopy VP-SEM. The pyramid shaped package promotes the formation of filament-shaped crystals, and reduction of solid substrate-bound crystals. These results provide evidence that a pyramidal package acts to structure water and mineral particles in an ordered manner.

Keywords: Pyramid power; Packaging; Water-treatment; Ice morphology

Introduction

Preservation and protection from external contamination are the main functions of the food packaging process [1]. This process also involves extension of the shelf-life of packaged food, while maintaining quality and safety. Packaging protects food and beverages from deteriorating environmental effects, such as microorganisms, presence or absence of moisture, odors, light, dust, pressure, heat, oxygen, insects, spurious, enzymes, dirt, and particles. All of these cause the deterioration of food and beverages [2]. Current food borne microbial outbreaks and the demand to minimize chemical additives in food require innovative ways to preserve foods while maintaining freshness, quality, nutritional content and safety. New techniques such as high pressure, active packaging, irradiation and modified atmosphere packaging have been used in the past. Pyramid shape packaging is another option which provides increased food safety and quality, a technology that can be combined with hurdles technology [3]. Pyramid shape packaging technique involves the use of packaging and containers made of dielectric materials such as plastic, fibreglass and paper molded into the form of a pyramid using the dimensional ratio as the measurements of the great pyramid in Egypt [4]. In recent decades, there has been increased interest in the proposed enhanced energy fields created by models of the great pyramid [5-9]. Many beneficial effects and applications of the pyramid power have been discovered such as theummification of organic material [5,6], method for maintaining razor blades [10], medical applications to regulate the disturbances of the human energy [11] and method for treatment of infectious diseases and allergies [12,13]. The pyramid structure can alter the pH of the solution contained within the pyramid. It has also been shown to promote moisture loss of internal biological samples, along with a threefold increase in the decomposition ratio of aqueous hydrogen peroxide (H₂O₂) [14]. A recent study revealed that hollow Pyramidal structures which contained milk inhibited the growth of microorganisms as compared with the control sample [15,16]. When pyramid-contained water was evaluated in medical devices, it was shown that frozen water formed filamentous structures [17]. A study has been conducted on the effect of pyramid-treated water on two groups of mice infected by cancer cases; the tumour size was shown to decrease by 50% in the group where pyramid-treated water was administered as compared to control. Another study demonstrated that pyramid-treated distilled water increased the indexes of newborns when orally administered as opposed to the intravenous administration of glucose solution [18]. The pyramid shape can actually impart a magnetic field as demonstrated by fluxgate magnetometer measurements of fibreglass versions of the great pyramid. These experiments show that the structure generated 310 Gamma with an accuracy of ± 20 [19]. By using the shape of the great pyramid in water packaging, we hope to combine both packaging and increasing the quality of water in one process based on the altered crystallization mode of water’s mineral content. Recent studies have demonstrated a correlation between electromagnetic fields and changes in water behaviour [20-24]. For example, water exhibits changes in physicochemical properties in response to variations of magnetic field intensity and/or frequency [23-25]. Lundager Madsen has concluded that the crystallization of sparingly soluble diamagnetic salts of weak acids such as phosphates and carbonates was accelerated by a magnetic field. He suggested that magnetic field disturbs dehydration by hindering the transfer of the proton to a water molecule, thus it is able to change the orientation of the proton spin [26,27]. The magnetic fields caused detectable changes in water and have been investigated in an attempt to determine the structure of liquid water [28]. Most current water-treatment techniques have disadvantages. These techniques produce magnetized-water that changes the crystallization mode of water’s mineral content, and alter the water’s molecular structure by using a static magnetic field induced from a permanent

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magnet or an electromagnet [20-29]. One disadvantage is they require special equipment and preparation, including an expensive permanent magnet, and an electric power source, if using an electromagnet. Unlike most current water-treatment techniques, pyramid packaging has no cost in the water-treatment process. In addition, the process is a simple as designing the proper dimensions in the packaging materials. Pyramidal package is a multi-use liquid package. The pyramid shape power source is free and inexhaustible. It can be used anywhere as a mobile water-treatment package because it does not combine any complex operations or extra equipment. It is capable of reducing the cost of storing and water treatment. Because of the various costs and complexity of current water-treatment methods, alternative techniques are a top priority for food scientists. The main objective of this research is to develop food preservation and packaging technique for liquid food products. The specific objective is to determine the effect of Pyramidal package on the crystallization mode of water’s mineral content. This study is the first study to use the pyramid shape in the form of a fifth-sided sealed package, in comparison with previous experiments that have been conducted by placing the samples, such as milk, inside a specimen container, and then placing it inside a four-sided hollow pyramidal structure, which is designed with an open square base, as mentioned in all previous literature [15,16].

Materials and Methods

Container manufacturing

A laser cutting system was used to manufacture three transparent containers made of Poly Methyl Methacrylate (PMMA) sheets with 3 mm thickness as they appear in the three design planes of figures 1A-1C. For each type of package, a hole 25 mm in diameter was made in the position that appears on the design plans of figures 1A-1C. The slope Angle is highly critical to the effectiveness of the pyramid container. It is the angle between the central line of any triangle base of a pyramid and the center line of the square base (Figure 2). Pyramidal container with a slope angle of 52° (Figure 3A), the height of the pyramidal container is 203 mm and the square base length is 323 mm. The same dimensions as the Cheops pyramid in Egypt. The volume of the pyramidal containers can be found by the formula volume=1/3b²h where b is the area of the base and h is the height from the base to the apex. Two containers with nearly the same volume as the pyramidal container were also generated. A square container (Figure 3B) with 200 mm side length and 200 mm height, The volume of the square container can be found by the formula: volume = s²h where s side length, h the height of the container. A rectangular container (Figure 3C) was also made with 100 mm side length, 100 mm width and 200 mm height. The volume of a rectangular container can be found by the formula: volume= lwh where l is the length, w the width, and h the height of the container. Linear Low Density Polyethylene film (LLDPE), which is commonly used in food packaging films for bags and sheets, was designed as a bag with the same volume as the three containers to isolate the internal surface of the containers from direct contact with water to avoid any interaction with the acrylic or with the acrylic adhesive.

Experimental area preparation

The three containers were kept in a single room where the distance between each container and between the walls was 2 meters. All containers were placed on three surfaces identical in shape, size and height. Two sides of the square base of each container were oriented in the magnetic North-South direction using a compass.
Sample preparation and variables determination

The experiment was conducted with mineral bottled water, which was placed inside each of the three containers, and then the three containers were closed with rubber stopper to avoid the interaction.
with the atmosphere. The mineral water contains trace amounts of potassium, sodium, magnesium, bicarbonate, chloride and sulphate. The experiment was performed at room temperature (~30°C). A 5 ml aliquot of water sample was collected to determine from each container alteration of the water structure by examining the ice structure. The ice structure was examined by variable pressure scanning electron microscopy VP-SEM at microscopy unit-institute of bioscience -University Putra Malaysia to determine the effect of container shape on the ice surface morphology. After 24 hours of storage. The examination was done by placing ~ 0.30 mL of the sample inside the VP-SEM specimen holder. The water started to freeze when the temperature of the experiment was set to -12°C. Once the pressure of 100 pa was reached the sample was monitored at low magnification (~100x) for surface morphological changes.

Results and Discussions

Based on the previous literature, pyramid shapes can induce a magnetic field [19]. In addition it has been shown that magnetic fields can alter the water molecular structure and the crystallization mode [20–29]. Figure 4A shows the mineral particles’ distribution in the water sample which was kept inside a pyramidal package made of PMMA for 24 hours at -12°C. It also shows that the ice surface has morphological changes; it is filament-shaped and is surrounded by minerals which also adopt a filamentous shape. Figures 4B and 4C show the mineral particle distribution in the water sample that has been kept inside square and rectangular shape containers respectively made of PMMA. The ice surface has different morphological changes and neither the water nor the minerals form filamentous particles. These results are in agreement with that of the literature in which the effect of pyramid shape can be observed as filament-shaped structures in frozen water [17]. These results provide evidence that the pyramid packaging shape has an effect on mineral water kept inside them. Furthermore, this confirms that the containers and packages which molded into the form of a pyramid shape will acquire the same beneficial properties of the pre-mentioned hollow pyramid structures. This study also shows evidence that pyramidal packaging has an effect on water’s molecular structure, similar to the effect of a magnetic field on the crystallization mode of water’s mineral content, which manifests in the change from the dendritic and solid substrate-bound as shown in figures 4B and 4C to the form of separate filament-shaped crystals as shown in figure 4A, after the water has been kept inside the pyramidal package for twenty-four hours. The ability of the pyramid to induce a low-frequency magnetic field is assumed to be the responsible factor behind the filament-shaped crystals’ formation, and the reduction of the solid substrate-bound crystals. Based on the aforementioned effects, the pyramidal package works as a water treatment device with an effect on water’s mineral content similar to the commonly known magnetic treatment devices mentioned in previous literature. Pyramid shape packaging technique provides great potential for beneficial packaging systems which can improve human health and relieve disease [18] also can aid in the transition from traditional packaging materials called “passive packaging” to active and sustainable packaging, which has many benefits for human health without increasing the cost of packaging and without any physical or chemical treatment for the packaging materials. The effect of packaging shape on water works as a
gateway for other researchers to study the effect of packaging shape on all kinds of food and its impact on our health.

Conclusions

This article has examined the effect of pyramidal, square and rectangular packages on mineral water using VP-SEM, which is indirectly calculated on ice surface morphology. The VP-SEM examination of ice is an effective means to reflect ice morphological changes. It has been shown that the pyramidal package affects the mineral water’s crystallization mode by altering the surface morphology of ice that appears in the formation of filament-shaped crystals, and reduction of solid substrate-bound crystals. The effect of square and rectangular packages shows a different morphological change that appears in the formation of solid substrate-bound crystals. It has been difficult to establish a relationship between the effects of packaging shape on water and its beneficial properties for human health, as mentioned in previous literature. Further research is needed to determine quantitative methods of analysis. In the future, it will be necessary to study the relationship between the effect of packaging shape and water molecular structure by combining VP-SEM and other approaches such as FT-IR for water molecular structure examination to understand why pyramid-treated water is beneficial to human health.

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