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The Effect of Packaging Materials on The Quality of Children's Jelly Candies with Artificial and Natural Color

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ABSTRACT

Natural red dyes extracted from red beetroots were identified (betalain) and determined as its usage in colored children's candy because it has a safe effect on health, compared with artificial pigments (Carmosine). The jelly candy was colored using different concentrations (10, 15 and 30 %) of natural color, different packaging material was used (Metallized polypropylene MTPP, a box of polyester PET, high-density polyethylene HDPE and a two-sided package of Metallized polypropylene and transparent polypropylene MTPP+ TPP) and studied, the effect of packaging materials on the stability of pigment and the retention of the good color degree of degradation during storage at room temperature and the refrigerator was analyzed, the results indicated that the best extraction method of the natural pigment using 3% citric acid. Also, the best packaging material used for keeping the candy from deterioration was MTPP followed by PET, MTPP + TPP, while HDPE packages showed a clear deterioration of the natural and artificial pigments during storage. Adding 3% of the natural pigment to the candy was significantly better than 1, 2% and have higher sensory evaluation. The objective of the study is to extract of the natural betalain pigment from red beetroots and then use in coloring children's candy (jelly) compared with the artificial pigment (carmosine) study the effect of the packaging material on preserving the jelly from external influences, and study the stability of the betalain pigment during the storage period.

1. Introduction

Children's candy has played an important role in food cultural traditions, and candy in general is deemed children's food because of its strong effect on health. Therefore, attention should be given to children's candy; however, evidence suggests that candy can have a place in an overall lifestyle that supports health, wellness, and happiness. (Hornick, et al., 2014, Duyff, et al., 2015) Candy, also called sweets or lollies, is a confection that features sugar as a principal ingredient. And called sugar confectionery, whose main ingredient is sugar, normally incorporated in the form of sucrose syrup and/or glucose, with additives such as gelling agents, acids, aromas, and food colorants (Hani, et al., 2015) Color additives are used in foods, beverages and candy for various reasons. They help correct natural variations in the actual color of the product and for changes that may occur during processing and storage. Providing color identities to otherwise colorless foods Colors make products more visually appealing and they emphasise or identify flavors normally associated with various applications. Color additives may be natural or artificial (Choo, 2018). The color of food is often associated with the flavor, safety, and nutritional value of the product.

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Synthetic food colorants have been used because of their high stability and low cost. However, consumer perception and demand have driven the replacement of synthetic colorants with naturally derived alternatives (Sigurdson et al., 2017). Color is one of the important attributes of food; it is an indicator of quality and is an essential sensory characteristic for consumer acceptance. Pigments from natural sources are gaining importance because of their enormous health benefits and because of the association of synthetic dyes with various health hazards, especially within initiating and spreading of chronic diseases, Among the naturally derived food colorants, carotenoids, chlorophylls, anthocyanins and betalains are commonly used (Stintzing and Carle 2007). Nature produces a variety of colorful compounds and hence color serves as a psychological adjectival measure for the ruling of food quality. Therefore, the color of natural food ingredients plays a crucial role in food. When natural pigments that can impart color even to processed foods are extracted, hence, their stability in terms of appearance and their molecular safety becomes vital. The length of constancy is not just until the product reaches the consumer, but also after their consumption, so the expected biological functions of pigments are minutely transported. betalains from pigments water-soluble (Azeredo et al., 2009). betalains provide protection to humans against stress-related disorders by inhibiting lipid oxidation and peroxidation (Kanner et al., 2001), impart anti-inflammatory effects (Gentile et al., 2004) and offering superior antiradical and anti-oxidative activities (Butera et al., 2002 and Stintzing et al., 2005). Due to the good health benefits of natural pigments, especially betalain pigment, it was extracted from natural sources such as red beets and applied in the field of coloring children's candy. Research on red beet (*BETA VULGARIS, L.*) has increased rapidly in the last contract due to the presence of brightly colored water-soluble pigments consummated by its richness of antioxidants, neuro-stimulators and strong anti-hypertensive, hepatoprotective protective and anti-cancer effects and antimicrobial activities. The importance of red beet continues because of its high red dye content, namely betalain, which shows excellent hue values appropriate for applications in food and pharmaceutical products. Although many plants accumulate betalains, red beet is approved for food and pharmaceutical applications (Jackman and Smith, 1996). by the US Food and Drug Administration (FDA). The crop yield of red beet ranges from 50 to 70 t/ha, with betanin content ranging from 40 to 200 mg betalain /100g fresh (0.4 –20 mg/g of dry) beetroot; a level that has not been reached with any other betalain-producing crop. Red beet is the only allowed source of betalain approved for foods in the United States (Code of Federal Regulations, 21 CFR 73, 40). Although these water-soluble pigments are stable between pH 3 and 7. to improve the red color of tomato pastes, sauces, soups, desserts, jams, jellies, ice creams, sweets and breakfast cereals. Therefore, betalain dye is used in food coloring, especially in children's candy. (Pavokovic et. al., 2009). Jelly is one of the favorite candies among people of a wide range of ages, especially children. Jelly typically varies in shape, taste and color (Oktavianti, 2003). Jelly is defined as chewy candies consisting of mostly blending together different ingredients, controlling the various characteristics of jelly candy, such as texture, taste, and appearance. The primary ingredients include water, gelatin, sweeteners, flavors and colors. (Habilla et al., 2011). Usually artificial colorings were added to jelly sweets because they are to enhance colors make the candy look more appealing, and help to improve the visual appearance of the products and distinguish their high stability and low cost. (Hamed, 1999 and Gregory, et al., 2017). It has been observed that consumption of food dyes has increased by 500 percent in the past 50 years, Products that were found to contain non-permitted artificial colors or exceeded the maximum level of colors, posed a health risks to the consumers. The population at greatest risk is children aged between 2-5 years old, due to their low body weight and age. Artificial colors in large quantities may cause adverse reactions (Dana, 2010 and Food Authority, 2014). Consumer watchdog CSPI says food dyes can cause everything from hyperactivity and allergic reactions to cancer. The use of naturally-extracted colors in food and sweets applications has increased considerably over the last few years. And that was attributed to increase consumer demand for natural products and the avoidance of artificial food additives. Especially as consumer demand for wholesome and healthful foods grows, so does the use of natural colors, to avoid the health damage caused by artificial colors. (Neelwarne, 2013). Sugar candy products represent a unique and rising area for natural color applications. There is currently increased the interest in using natural colorants because of their non-toxicity and beneficial health effects, mainly as antioxidants (Chethana, et al., 2007; and Stintzing, et al., 2005) These problems were overcome by using packaging technology. Packaging is the gadget that protects, contains, and sell product so that the environmental effect on the food in the package is minimised. Whereas, effective packaging is indispensable to the health and welfare of the consumer as is the desires higher quality and safer food with a longer shelf-life. Color is an important quality advantage of candy that is affected during storage time by environmental conditions and packaging. As packaging properties influence the color of food, it was a comparative study of the effects of varied packaging materials especially impermeable packages for oxygen. (Lozano, et al. 2007). found that polyesters are the most used in food packaging and provide a good barrier to gases (oxygen and carbon dioxide) and moisture. It also has good resistance to heat, mineral oils, and solvents PET is becoming the packaging material of choice for many food products because it has better flexibility and less hardness. (Kirwan and Strawbridge, 2003) Polyolefin is the term for polyethylene and polypropylene, the most widely used plastics in food packaging, The simplest and most cheap plastic includes flexibility, strength, lightness, stability, moisture, chemical resistance, and easy processing ability. High-density polyethylene is rigid, permeable to gas, easy to process, and easy to form. (Van Willig et al., 2002; Marsh and Bugusu, 2007) Metallized films are plastics containing a thin layer of aluminum metal (Fellows and Axtell, 2002). These films have improved barrier properties to moisture, oils, air, and odors, and the highly reflective surface of aluminum is attractive to consumers. More flexible than laminated films, metalized films are mainly used to pack snacks. (Mir, et al., 2015) Laminate could be used for the packaging of quince candy with a storage life of more than 4 months as it was better able to retain its physicochemical and antioxidant properties in comparison with polyethylene and plastic jars. Also, (Singh and Pathak, 2016) concluded that the benefit of Ber Candy was in the LDP packet followed by the plastic jar and a glass jar. LDP packets were better in comparison to glass jars and plastic jars for packaging candy at ambient temperature and the candy was found to be good condition even after 9 months of the storage in LDP packet. The candy products are getting more circulation because they are delicious, easy to eat and enjoyed by many of all age groups, especially children. So packaging containers play a vital role in maintaining quality for longer. So the evaluation of packaging materials is very important for candy. The objective of the study is to extract of the natural betalain pigment from red beets and then use in coloring children's candy (jelly) compared with the artificial pigment (chromatin) study the effect of the packaging material on preserving the jelly from external influences, and study the stability of the betalain pigment during the storage period.

2. MATERIALS AND METHODS

Materials

Sources of colorant materials and additives

Red beet (*Beta vulgaris L*), Sugar (sucrose), corn syrup, and gelatin were purchased from a local market, Cairo, Egypt.

Citric acid, flavor (strawberry) and synthetic color (carmoisine) were obtained from ADWIC (El-Nasser Pharmaceutical Chemicals Company).

Packaging materials

Four types of package materials were used: polyester (PET), high density polyethylene (HDPE), with two faces, each with a type of material (transparent polypropylene (TPP) and metallized polypropylene (MTZ PP).

Polyester box (PET) and high-density polyethylene film were obtained from an Arabic medical packaging company (Flexpack), Cairo, Egypt. Whereas metallized polypropylene film (MTZ PP) and transparent polypropylene film were obtained from the Islamic Company for packages in the 6th October city, Giza. Egypt. Characteristics of different packing materials, such as thickness, gas permeability and water-vapor permeability, are shown in Table 1.

Table 1. Characteristics of different packaging material

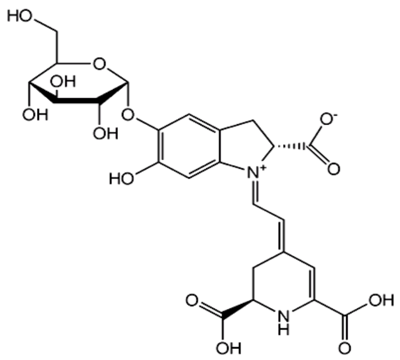
Degree of gas permission	Packaging materials	Thickness (mm)	Gas – permeability			Water-vapor permeability $gm/m^2/24hrs/atm$
			O_2 $cc/m^2/24hrs$	N_2 $cc/^2$ /24hrs	CO_2 cc/m^2 /24hrs	
High	HDPE	30	3501	2301	5185	0.7
High	TPP	20	529	311	1590	1.67
Medium	PET	122	87	26	494	1.82
Low	MTZPP	50	18	9	38	0.52

HDPE: high density polyethylene, PET: Polyester, TPP: Transparent polypropylene, MTZPP: Metallized Polypropylene

Methods

Extraction of Natural red pigments from red beet roots

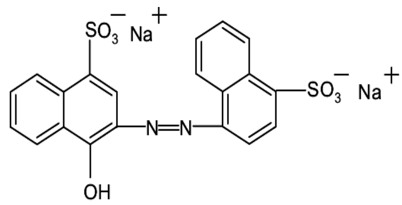
The extraction of natural red pigments (betalain $C_{24}H_{26}N_2O_{13}$) from red beetroots was performed as described by (Du and Francis, 1975). Different concentrations of citric acid (1%, 2% and 3%) were used in the extraction of those aforementioned pigments. The extracted solutions were concentrated by using a rotary evaporator under vacuum at a low temperature (50 ºC) whereas pigments are very sensitive to high temperatures. (Francis, 2000).



Chemical composition of betalain

Preparation of Artificial pigments

Artificial pigment was prepared with 0.1% synthetic color (Carmoisine $C_{20}H_{12}N_2Na_2O_7S_2$).



Chemical composition of carmosine

Determination of the separated pigments

The best method of pigment extraction was chosen. The natural red pigments extracted using the best method chosen were determined according to Beer-Lambert Law:

A = a. b. c

Where: A = absorbance

a = absorptivity

b = cell length = 1cm

c = concentration of separated natural red pigment in (1cm).

Identification of the separated natural red pigments

Identification of natural red pigments extracted from red beetroots was carried out using spectrophotometer analysis by the ultraviolet spectrometer Unicom SP1800. The absorbance (A) was measured at wavelengths ranging from 450 nm to 570 nm.

Preparation of jelly

Jelly was prepared in the laboratory by adding different levels of red beet pigments, i.e., 0.1, 0.2, and 0.3 w/w in the laboratory using the traditional procedure. The formulation of jelly is shown in Table (1).

Table 2. The formulation of Jelly

Ingredients	%
Sucrose	84.0
Gelatin	15.0
Citric acid	0.20
Flavoring agent	0.10
Sodium benzoate and potassium citrate	0.10
Ascorbic acid	0.10
Color (red beet pigments extract)	0.5

The jelly candy was added with 0.5% artificial pigments (AP) (Carmoisine 0.1%) while the treatments of jelly candy was added with 0.5% natural pigment (NP) (red beet pigment extracted 0.1, 0.2 and 0.3%)

Preparation of packages

The plastic film was cut to (15 x 20 cm) using a cutter machine Packages (Paper Trimmer NIS, Japan) and sealing machines (Moulinex Vacumaster, France / model de pose; and Audionvog VM) were used for sealing the packages

Packaging of Jelly

After manufacturing the jelly candy with the natural pigment (NP) (betalain pigment extracted from red beets with concentration 10, 15, 30% of the extracted citric acid 0.3%) as well as the jelly candy with the addition of the artificial pigment (AP) (Carmoisine pigment), each type of candy was divided into four sections and each section of the sweets was filled in a package of the previous packages which are: polyester (PET), high density polyethylene (HDPE), metallized polypropylene (MTZ PP) and a package with two faces, each with a type of material (transparent polypropylene (TPP) and metallized polypropylene (MTZ PP) under study Then part of the packages packed with candy is stored at room temperature and the other part at refrigerator temperature (4±1˚C) with weekly samples drawn for testing.

Color Analysis

Visible Absorption spectrum

Absorption measurement with a cell (light-path length, 1cm) was made against distilled water blank between 400 nm and 700 nm with a spectrophotometer uncanny “SP1800”. All measurements were conducted in duplicate and averaged.

Stability of color during storage

Test the stability of red pigments during storage at room temperature (around 25 °C) and fridge temperature (4 °C) weekly by measuring the visible absorption spectrum.

Sensory evaluation

The samples of Jelly Candy were sensory evaluated for color, taste, odor, texture and overall quality during the storage period according to the method described by (Lawless and Heymann, 1998).

Statistical analysis

The collected data on jelly Candy were statistically analyzed and carried out with the SPSS. In SPSS data were subjected to one-way analysis of variance (ANOVA) to statistically determine the variation between groups followed by Duncan’s multiple range post hoc test for pairwise comparisons. The data are shown as the mean ± SE. Variations were considered significant at $P < 0.05$.

Results and Discussion

Identification of separated natural red pigments from red beetroots:

The maximum absorbance of betalain pigments extracted from red beetroots is shown in figure 3. The maximum absorbance observed was for wavelengths ranging between 505 nm and 540 nm These results were in agreement with those reported by (Abd-El-Latif et al., 1992; and Sallam 1996) who found that the maximum absorbance of betalain naturally pigments were ranging between 500 nm and 545 nm. The results indicated therein in figures (1, 2, and 3) reveal that the natural red pigments extracted from red beetroots were betalain.

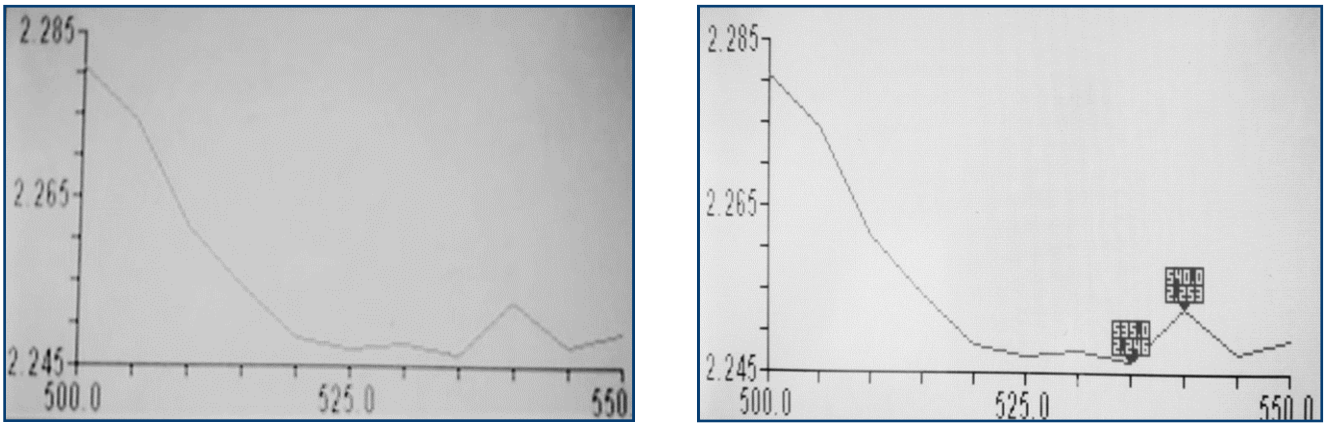


Figure 1. Wavelength Absorbance of pigment extracts from red beet By Citric Acid (1%)

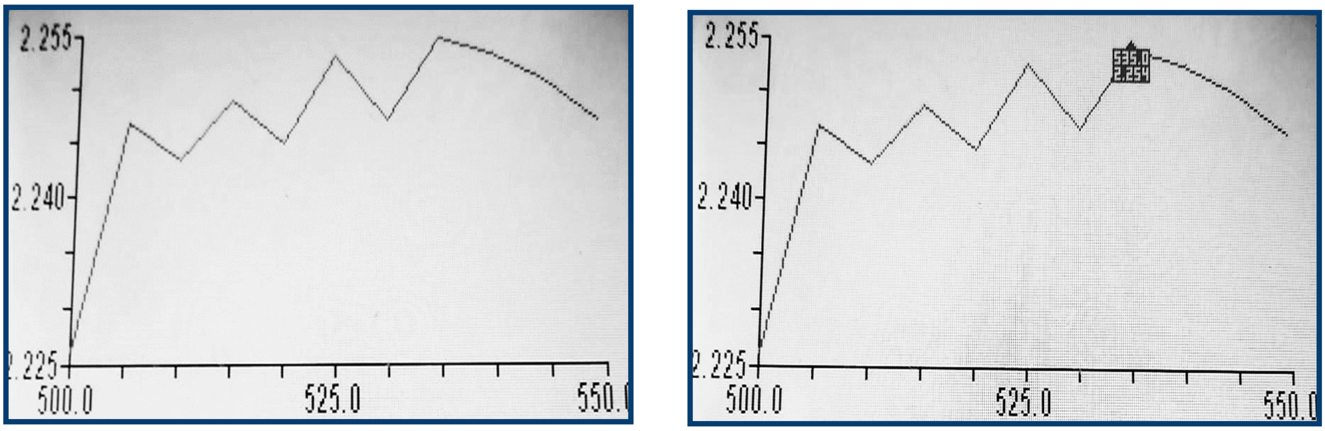


Figure 2. Wavelength Absorbance of pigment extracts from red beet By Citric Acid (2%)

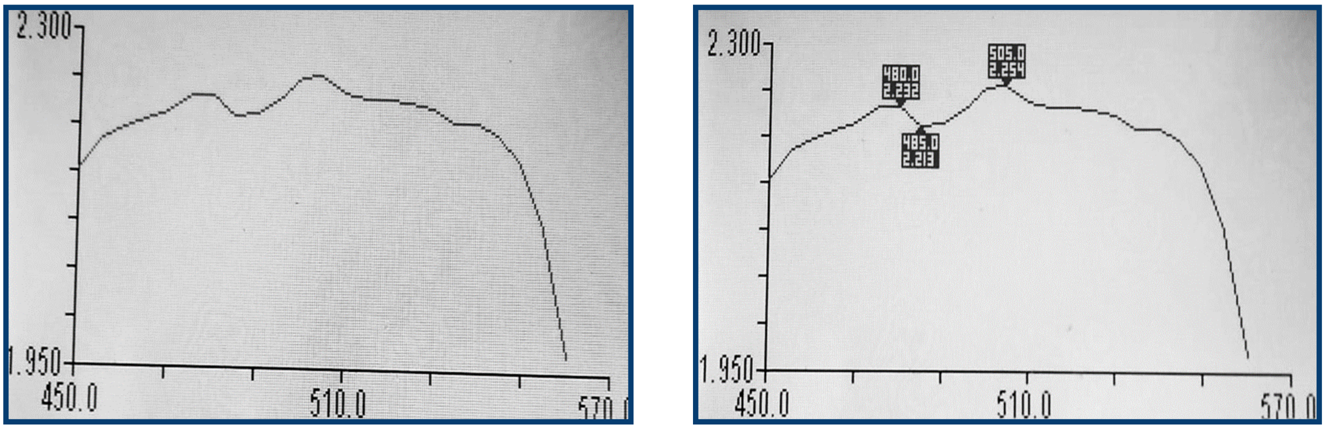


Figure 3. Wavelength Absorbance of pigment extracts from red beet by Citric Acid (3%)

Determination of natural red pigments extracted from red beetroots

The content of natural red pigments extracted from red beetroots was 13.15, 13.99 and 14.72mg/100g using 1%, 2% and 3% citric acid solutions, respectively.

In this study, it was observed there is a wide difference between the packages according to their effect on the degree of color stability, whether natural or artificial, because of the different permeability and transparency of the different types of packages as shown by the following results:

Due to the importance of sweets for children and consumer, it is demanded to use natural colors due to their health importance, attention has been paid to study the effect of packaging materials on color stability throughout the storage period because packages are very important factors to maintain the quality of the product from the external factors, At the same time barrier properties of packaging material are responsible for product quality deterioration (Lazića, et al., 2010).

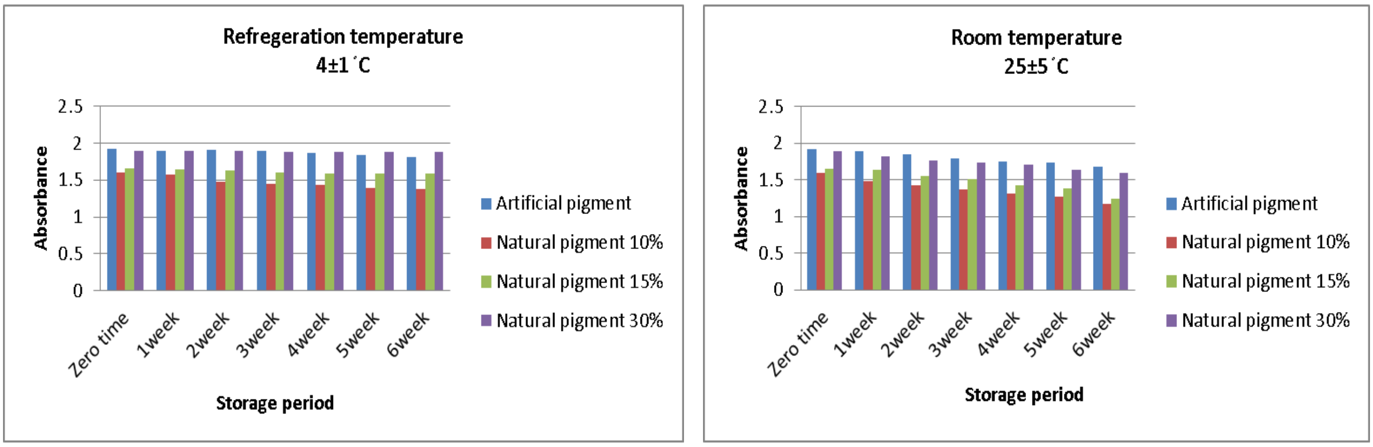


Figure 4. Effect of Metallized Polypropylene (MTZPP) Package on the stability of natural pigment compared with artificial pigment in Jelly candy during storage

The effect of packing in metalized polypropylene (MTZPP) and storage period on the color stability of jelly candy was analyzed at specified intervals of time, and the data is presented in Figure 4. It was noted that this package maintained the stability of the color (natural and artificial) from deterioration throughout the storage period, whether at refrigerator or room temperature. With a higher concentration of pigment at 30%, the stability of color was 1.893 at zero time and 1.886 at the end of the storage period. As the Metalized polypropylene package is provided with the appropriate conditions for storage and preserving candy, against the influence of external conditions from oxygen and light because it is one of the dark and low packages permeability to oxygen (Table 1). These results are in agreement with (Del Caro, 2004) who reported that the good barrier properties of packages also affect the maintenance of candy's quality by keeping an oxygen free environment, as observed in the candy that is packaged in laminate. Using laminate as a packaging material. Also, (Mir, et al. (2015) reported that oxygen-impermeable films prevent this change in color, as is evident from the laminate package. whereas betalain is the main component of the red colorant extracted from Beta vulgaris. So, betalain require packaging under an oxygen barrier, and storage in the dark to maintain stability (Rayner, 1993).

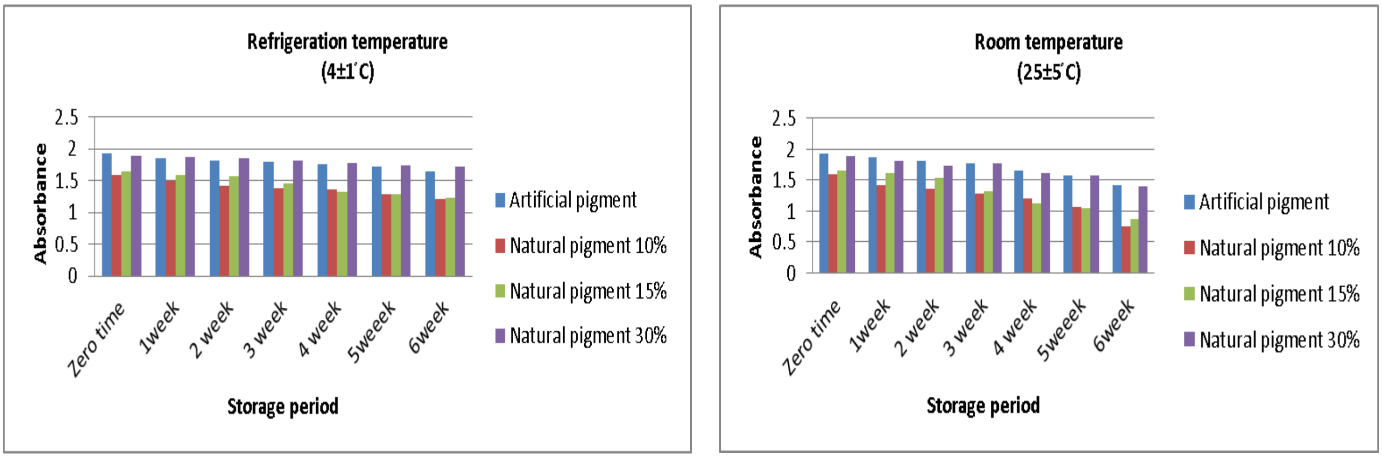
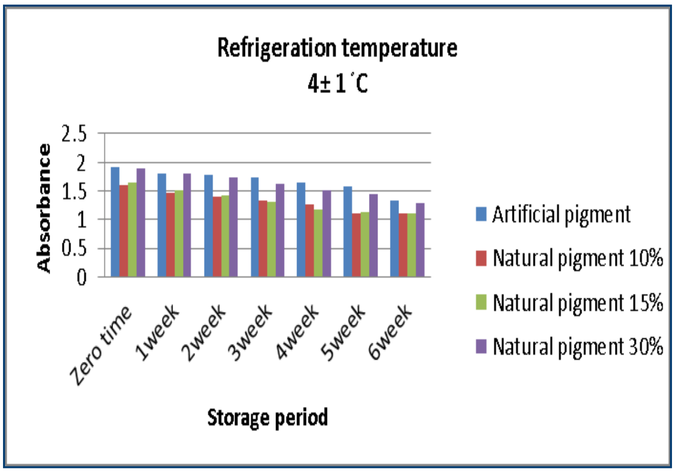


Figure 5. Effect of polyester (PET) Package on the stability of natural pigment compared with artificial pigment in Jelly candy during storage

The candies were packed in polyester box at different storage temperatures as shown in Fig (5). The results indicated that candies retained their color during storage periods, while color degree decreased at the end of storage periods to 1.205, 1.234 and 1.712 using 10, 15 and 30% natural pigments respectively. While the decline was higher with storage at room temperature, it is 0.752, 0.873 and 1.405 using 10%, 15% and 30% respectively. Also, artificial color decreased from 1.924 to 1.654 and 1.423 after 6 weeks from storage at refrigeration and room temperature respectively. Candies packaged in polyester boxes retained their color for long periods, but a decrease in the color degree appeared at the end of the storage periods, Although they are low in the permeability of oxygen, And well the effect of water-vapor permeability compared with other packaging (Table 1) (Piringer and Baner, 2000) reported that, PET is highly impermeable to aromas and gases, but has little resistance to water vapor. This may have led to a degradation of the pigment and a change of color at the end of storage may be the presence of moisture may lead to increase the microbial growth, which helps the decomposition of the pigment and speed of corruption. (Chowdhury, et al*.,* 2011) And on the other hand, this package is transparent, which helps the consumer to see the product inside and at the same time leads to the sweets being exposed to strong light, which negatively affects the color fastness in the candy for a long time, which led to the deterioration of the color at the end of the storage period.

Because this type of packaging is transparent, it allows the transmission of light, which plays a role in the deterioration of the color. Degradation due to light is caused by the absorption of light in UV and visible wavelengths leading to the excitement of electrons in betalain chromophores to a more energetic state. This results in for higher reactivity or lowered activation of the molecule (Jackman and Smith, 1996).



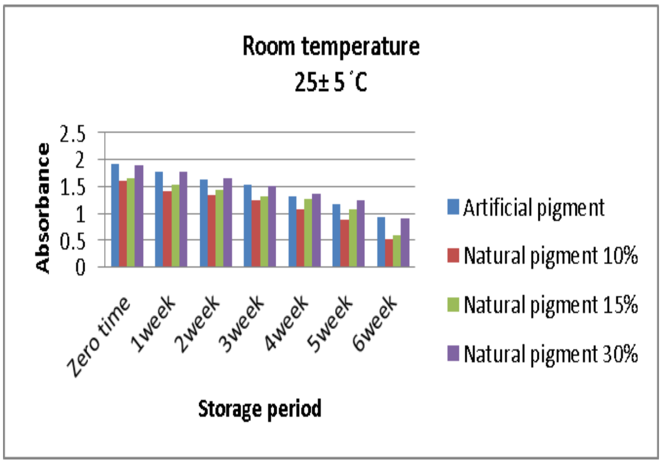
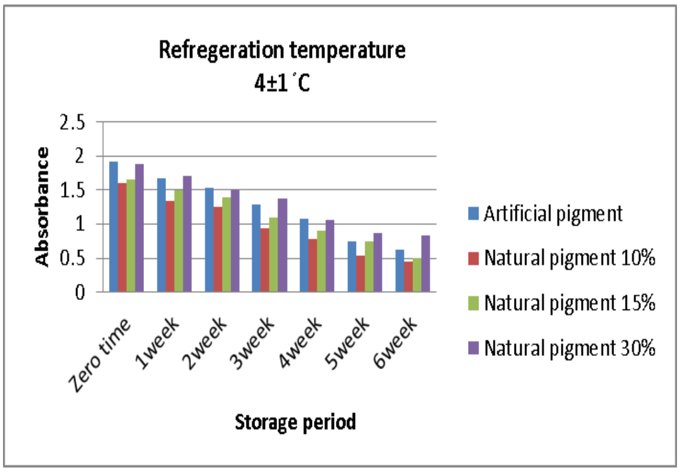


Figure 6. Effect of Tow Face (Metallized and transparent polypropylene) Package on stability of natural pigment compared with artificial pigment in Jelly candy during storage

The change in color of Jelly candy packed in the two faces (Metallized and transparent polypropylene) is presented in Fig (6). This package preserved the color at the beginning of the storage period for two weeks, and then partial deterioration in the color occurred during storage till the end of the storage period, especially at room temperature. Where, the color decreased from 1.924 to 0.923 at the end of storage using artificial pigment and reached 0.523, 0.597 and 0.895 using 10%, 15% and 30% natural pigments respectively, after 6 weeks. Whereas the partial degradation of the pigment was less when preserved at the refrigerator temperature using 30% concentrations, it reached 1.893 to 1.292 at the end of storage period. The two-sided packaging (metallic polypropylene and transparent polypropylene) packaging showed partial and total deterioration of the pigment, whether natural or industrial, over the different storage periods. This may be due to the presence of transparent polypropylene (TPP) in a double-sided package, because they are characterized by oxygen permeability as the presence of oxygen affects the stability of the pigment and leads to its deterioration has been reported (Neelwarne, 2013).



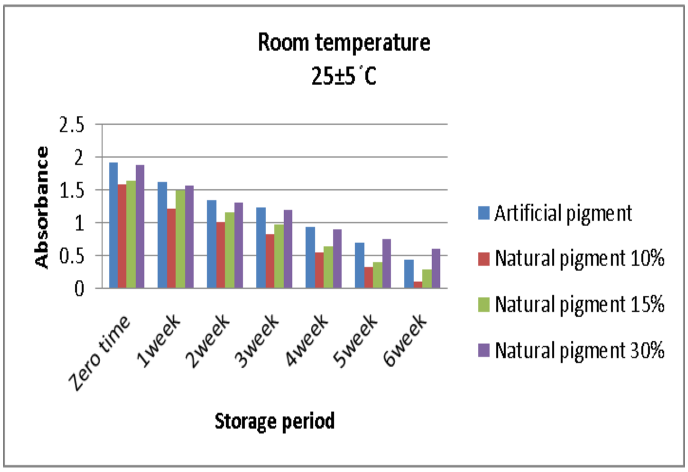


Figure 7. Effect of High-density polyethylene (HDPE) Package on the stability of natural pigment compared with artificial pigment in Jelly candy during storage

Fig. (7) shows the color deterioration of jelly candy packaged in high-density polyethylene (HDPE) The results observed a very rapid and severe deterioration in the natural color of jelly candy during the first week of storage. Especially, at room temperature and low pigment concentration, whereas the color stability was reduced from 1.596 to 0.116 at the end of storage, using 10 % pigment concentration. Artificial pigment reduced from 1.924 to 1.074 and 0.945 respectively, after 4 weeks of storage at refrigeration and room temperature. These results showed total deterioration of the pigment, whether natural or industrial, over the different storage periods. This may be due to high-density polyethylene (HDPE) packaging because it is characterized by high oxygen permeability, as it is observed both betaxanthin and betalain are subject to deterioration in the presence of oxygen. There was a linear decrease in stability of betalain with increasing oxygen concentration. In addition to oxygen, hydrogen peroxide is another important atmospheric factor responsible for the rapid deterioration of beet pigments (Wasserman, et al., 1984), probably through rapid oxidation. The degradation of betalain follows first-order kinetics in the presence of oxygen. These observations are indicated that deterioration caused by oxygen may be irreversible and have a greater impact on the functionality of each pigment (Attoe and von Elbe, 1985; and Azeredo, 2009). On the other hand, since these HDPE packages are transparent and allow light permeability, the presence of light and oxygen at the same time leads to increase the degradation of pigments during storage (Herbach, et al., 2004). (Herbach, et al., 2004) demonstrated that the degradation of pigments by light depended on the presence of oxygen, since Light and oxygen have shown synergistic deterioration of betalain. As they are individually tested, light and oxygen caused 15.6% and 14.6% deterioration, whereas the combination between them caused 28.6% degradation, according to a study on the red beet pigments stability.

In general, it was noted from this study that the degradation of the pigment was greatly affected by different temperatures, as the low temperature (storage at refrigerator temperature) maintained the stability of the pigment throughout the storage period, unlike the high temperature (storage at room temperature) which showed a clear and fast deterioration in the pigment and a significant decrease in hue during sensory evaluation over different storage periods. (Neelwarne, 2013) reported that high temperatures are another factor responsible for the degradation of betalain and many other components that support pigment stability (Herbach, et al., 2006).

They mentioned that high temperature or heating lead to hydrolysis of the betalain dye, decarboxylation, and dehydrogenation, which produce other new compounds.

Sensory Evaluation Analysis:

The sensory evaluation of Jelly candy packaged in different packaging materials using different additives from natural and artificial pigments was analyzed at zero time and at the end of storage periods (six weeks). A complete organoleptic evaluation includes color, taste, odor, texture and overall acceptability.

Table 3. Effect of Different Packaging Materials on Sensory Evaluation of Jelly candy at Zero time

Packaging Materials	Treatment	Color	Taste	Oder	Texture	OA
MTZPP	AP	9.22±0.39[a]	8.20±0.74[b]	9.41±0.17[a]	8.91±0.02[a]	9.22±0.39[a]
	10%NP	8.15±0.26[b]	9.35±0.04[a]	8.71±0.34[a]	8.01±0.24[b]	8.68±0.74[ab]
	15%NP	9.52±0.24[a]	9.20±0.51[a]	9.42±0.33[a]	8.57±0.32[a]	9.16±0.25[a]
	30%NP	9.70±0.19[a]	9.11±0.72[a]	9.31±0.54[a]	8.78±0.64[a]	9.17±0.64[a]
PET	AP	8.93±0.26[a]	8.15±0.26[b]	9.26±0.28[a]	8.65±0.87[a]	9.04±0.82[a]
	10%NP	7.87±0.34[b]	8.76±0.34[a]	8.62±0.24[a]	7.82±0.45[b]	8.61±0.72[ab]
	15%NP	9.15±0.16[a]	9.13±0.67[a]	9.28±0.42[a]	8.55±0.96[a]	9.13±0.48[a]
	30%NP	9.43±0.07[a]	9.17±0.34[a]	9.36±0.55[a]	8.62±0.85[a]	9.15±0.39[a]
MTZPP + TPP	AP	8.52±0.23[ab]	8.12±0.08[b]	9.13±0.66[a]	8.43±0.48[b]	8.57±0.82[ab]
	10%NP	7.63±0.46[b]	8.24±0.25[b]	8.43±0.58[b]	7.62±0.55[b]	7.91±0.63[ab]
	15%NP	9.11±0.27[a]	9.11±0.18[a]	9.21±0.83[a]	8.52±0.62[a]	9.12±0.27[a]
	30%NP	9.26±0.18[a]	9.12±0.42[a]	9.15±0.62[a]	8.58±0.32[a]	9.14±0.29[a]
HDPE	AP	8.21±0.04[b]	8.11±0.23[b]	9.27±0.95[a]	8.25±0.66[b]	8.34±0.77[b]
	10%NP	7.54±0.16[b]	7.87±0.38[b]	8.22±0.68[b]	7.59±0.48[b]	7.65±0.86[b]
	15%NP	8.75±0.23[a]	8.68±0.72[a]	9.18±0.42[a]	8.47±0.77[b]	8.79±0.72[a]
	30%NP	8.89±0.27[a]	9.05±0.53[a]	9.12±0.57[a]	8.52±0.78[a]	8.82±0.83[a]

Values are represented as the mean ± SE. Means with different superscript in a Column differ significantly (P<0.05)
A PET: Polyester, HDPE: High density polyethylene
AP: Artificial Pigment, NP: Natural Pigment
MTZPP: Metallized polypropylene, TPP: transparent polypropylene
OA: Overall Acceptability
[1] Refrigeration temperature (4±1˚C)
[2] Room temperature (25±5˚C)

Results in Table (3) revealed that, the Jelly candy packaged at Zero time were high acceptable with all packaging materials and no significant difference between natural and artificial pigments.

Results in Table (4) revealed that, the Jelly candy that is packaged in MTZPP had the highest overall acceptability with all treatments especially, stored at refrigeration temperatures 7.13, 6.78,7.52 and 8.59 using artificial pigment , 10%,15% and 30% from natural pigment, respectively. While, HDPE packaging showed low acceptability with all treatments, and deterioration in color, especially using the concentration of 10% of natural pigments 4.16, 3.26 at the refrigerator and room temperature, respectively. Also, the results revealed that, no significant difference (p>0.05) between the PET box and MTZPP+ TPP package.

With the sensory evaluation carried out at the different storage stages, it was noticed that the metalized polypropylene package was the best package in maintaining the stability of the color for the consumer throughout the storage period, followed by the polyester package.

Table 4. Effect of different Packaging Materials on Sensory Evaluation of Jelly candy at the end storage (6 weeks).

Treatment	Packaging Materials	Color	Taste	Oder	Texture	OA
AP	MTZPP	$^{1}7.65\pm0.22^{ab}$ $^{2}6.71\pm0.67^{b}$	$^{1}7.16\pm0.22^{b}$ $^{2}5.33\pm0.54^{c}$	$^{1}7.11\pm0.24^{b}$ $^{2}6.08\pm0.33^{bc}$	$^{1}6.51\pm0.42^{b}$ $^{2}4.72\pm1.77^{c}$	$^{1}7.13\pm0.51^{b}$ $^{2}5.62\pm0.34^{bc}$
10%NP		$^{1}6.47\pm0.15^{b}$ $^{2}5.73\pm0.18^{bc}$	$^{1}7.14\pm0.12^{b}$ $^{2}6.05\pm0.34^{b}$	$^{1}7.25\pm0.42^{b}$ $^{2}6.18\pm0.27^{b}$	$^{1}6.02\pm1.58^{bc}$ $^{2}5.58\pm1.23^{bc}$	$^{1}6.78\pm0.49^{b}$ $^{2}5.61\pm0.18^{bc}$
15%NP		$^{1}8.43\pm0.25^{a}$ $^{2}7.97\pm0.36^{ab}$	$^{1}7.80\pm0.74^{ab}$ $^{2}6.43\pm0.24^{b}$	$^{1}8.01\pm0.75^{a}$ $^{2}7.87\pm0.18^{ab}$	$^{1}7.42\pm0.42^{b}$ $^{2}6.11\pm0.35^{b}$	$^{1}7.52\pm0.33^{ab}$ $^{2}6.97\pm0.54^{b}$
30%NP		$^{1}8.60\pm0.79^{a}$ $^{2}8.48\pm0.36^{a}$	$^{1}8.31\pm0.29^{a}$ $^{2}7.68\pm0.18^{ab}$	$^{1}8.44\pm0.83^{a}$ $^{2}8.27\pm0.65^{a}$	$^{1}7.89\pm0.55^{a}$ $^{2}7.52\pm0.18^{ab}$	$^{1}8.59\pm0.18^{a}$ $^{2}7.76\pm0.14^{ab}$
AP	PET	$^{1}70.32\pm65.^{ab}$ $^{2}6.54\pm0.25^{b}$	$^{1}6.37\pm0.17^{bc}$ $^{2}5.27\pm0.35^{c}$	$^{1}7.25\pm0.38^{b}$ $^{2}5.78\pm0.16^{bc}$	$^{1}6.05\pm1.45^{bc}$ $^{2}4.31\pm0.17^{c}$	$^{1}6.42\pm0.24^{bc}$ $^{2}6.12\pm0.13^{bc}$
10%NP		$^{1}5.97\pm0.84^{b}$ $^{2}5.34\pm0.16^{c}$	$^{1}6.16\pm0.62^{bc}$ $^{2}5.19\pm0.55^{c}$	$^{1}6.03\pm0.65^{bc}$ $^{2}5.24\pm0.17^{c}$	$^{1}6.01\pm1.38^{bc}$ $^{2}4.19\pm1.18^{c}$	$^{1}6.11\pm0.35^{bc}$ $^{2}4.96\pm0.15^{c}$
15%NP		$^{1}7.65\pm0.23^{ab}$ $^{2}7.57\pm0.75^{ab}$	$^{1}7.33\pm0.56^{b}$ $^{2}6.59\pm0.88^{b}$	$^{1}7.78\pm0.32^{ab}$ $^{2}7.55\pm2.86^{ab}$	$^{1}6.86\pm0.34^{b}$ $^{2}6.51\pm0.16^{b}$	$^{1}7.22\pm0.44^{b}$ $^{2}6.77\pm0.64^{b}$
30%NP		$^{1}8.21\pm0.33^{a}$ $^{2}7.87\pm0.45^{a}$	$^{1}7.98\pm0.82^{a}$ $^{2}7.64\pm0.77^{ab}$	$^{1}8.13\pm0.42^{a}$ $^{2}8.04\pm0.35^{a}$	$^{1}7.62\pm0.77^{ab}$ $^{2}7.51\pm0.43^{ab}$	$^{1}8.19\pm0.63^{a}$ $^{2}7.78\pm0.28^{ab}$
AP	MTZPP + TPP	$^{1}6.83\pm0.28^{b}$ $^{2}6.01\pm0.27^{bc}$	$^{1}6.13\pm0.27^{bc}$ $^{2}5.21\pm0.62^{c}$	$^{1}6.01\pm1.23^{bc}$ $^{2}5.04\pm0.35^{c}$	$^{1}5.62\pm0.45^{bc}$ $^{2}4.06\pm0.71^{c}$	$^{1}6.37\pm0.94^{bc}$ $^{2}5.19\pm0.72^{c}$
10%NP		$^{1}5.42\pm0.22^{bc}$ $^{2}5.01\pm0.24^{c}$	$^{1}6.11\pm0.12^{bc}$ $^{2}5.07\pm0.10^{c}$	$^{1}6.01\pm0.08^{bc}$ $^{2}5.16\pm0.19^{c}$	$^{1}5.76\pm0.54^{bc}$ $^{2}4.03\pm0.14^{c}$	$^{1}5.94\pm0.51^{bc}$ $^{2}4.85\pm0.12^{c}$
15%NP		$^{1}7.56\pm0.13^{ab}$ $^{2}7.19\pm0.12^{b}$	$^{1}7.14\pm0.18^{b}$ $^{2}6.49\pm0.35^{b}$	$^{1}7.32\pm0.18^{b}$ $^{2}7.08\pm0.12^{b}$	$^{1}6.73\pm0.18^{b}$ $^{2}6.49\pm0.13^{b}$	$^{1}7.11\pm0.13^{b}$ $^{2}6.65\pm0.15^{b}$
30%NP		$^{1}8.17\pm0.54^{a}$ $^{2}7.63\pm0.42^{ab}$	$^{1}7.63\pm0.25^{ab}$ $^{2}7.22\pm0.21^{b}$	$^{1}8.11\pm0.45^{a}$ $^{2}7.98\pm0.35^{a}$	$^{1}7.32\pm0.32^{b}$ $^{2}7.02\pm0.25^{b}$	$^{1}7.84\pm0.29^{ab}$ $^{2}7.53\pm0.35^{ab}$
AP	HDPE	$^{1}5.62\pm0.16^{bc}$ $^{2}4.54\pm1.11^{c}$	$^{1}5.02\pm0.14^{c}$ $^{2}4.21\pm0.13^{cd}$	$^{1}5.26\pm0.15^{c}$ $^{2}5.02\pm1.05^{c}$	$^{1}4.23\pm1.26^{c}$ $^{2}3.87\pm1.35^{d}$	$^{1}5.14\pm0.27^{c}$ $^{2}4.52\pm1.35^{c}$
10%NP		$^{1}4.51\pm1.06^{c}$ $^{2}3.21\pm1.05^{d}$	$^{1}5.26\pm0.38^{c}$ $^{2}3.23\pm0.35^{d}$	$^{1}5.43\pm0.68^{c}$ $^{2}4.54\pm0.35^{c}$	$^{1}4.05\pm1.48^{d}$ $^{2}3.01\pm1.35^{d}$	$^{1}4.16\pm1.46^{cd}$ $^{2}3.26\pm1.65^{d}$
15%NP		$^{1}6.48\pm0.23^{b}$ $^{2}5.87\pm0.35^{bc}$	$^{1}6.43\pm0.74^{b}$ $^{2}4.61\pm1.05^{c}$	$^{1}6.36\pm0.12^{b}$ $^{2}5.62\pm0.35^{bc}$	$^{1}5.21\pm0.37^{c}$ $^{2}4.28\pm0.25^{cd}$	$^{1}5.98\pm0.14^{bc}$ $^{2}4.75\pm0.35^{c}$
30%NP		$^{1}7.01\pm0.14^{b}$ $^{2}6.23\pm0.35^{b}$	$^{1}6.67\pm0.17^{b}$ $^{2}5.97\pm0.24^{bc}$	$^{1}7.54\pm0.32^{b}$ $^{2}5.84\pm0.27^{bc}$	$^{1}5.86\pm1.08^{bc}$ $^{2}5.16\pm1.17^{c}$	$^{1}6.78\pm0.13^{b}$ $^{2}5.82\pm0.15^{bc}$

Values are represented as the mean ± SE. Means with different superscript in a Column differ significantly ($P<0.05$)
A PET: Polyester, HDPE: High density polyethylene
AP: Artificial Pigment, NP: Natural Pigment
MTZPP: Metallized polypropylene, TPP: transparent polypropylene
OA: Overall Acceptability
[1] Refrigeration temperature (4±1°C)
[2] Room temperature (25±5°C)

No significant difference (p>0.05) between most of the treatments of the natural and artificial pigment, with a different susceptibility to the candy according to the difference concentration of the pigment, where the higher the concentration of 30%, the better the consumer's susceptibility to the candy, while showed the storage in a double-sided package (metalized polypropylene MTZPP, transparent polypropylene TPP) and the high-density polyethylene (HDPE) packaging significant differences between the different concentrations of the pigment and between the natural and industrial pigment and preservation at room temperature compared with the refrigerator temperature, Noting that the pigment deterioration increased with a decrease in its concentration pigment in candy 10% > 15% > 30% . (Herbach *et. al.,* 2006) reported that, Thermal degradation of beet pigment mainly depends on the temperature level, the extent of heating, the presence of oxygen and the concentration of pigment.

The general acceptability was higher for the candy with a natural pigment added to it compared to the candy with added artificial pigment (Dey and Nagababu, 2022) reported that, candy Most of the food artificial colors tested in the conventional toxicity experiments showed toxic effects at a very high level of intake, as some unwanted changes appeared on the candy with artificial pigment added (carmosine) in addition to the appearance of signs of spoilage and some microbial growth on it at the end of the storage period compared to the candy with added color natural because betalain pigment has an antimicrobial effect.

Recently, betalains have received more attention because betanin (betacyanin) has shown antiviral and antimicrobial activity (Delgado-Vargas *et. al.,* 2000).

The antioxidant activity of betalain pigments from plants was evaluated All tested betalains exhibited strong antioxidant activity (Cai and Corke. 2003). Extensive research has already proven that betalain from beetroot impart a high antiradical effect, displaying strong. As a result, the candy with a natural pigment added (30%) showed high acceptance by the consumer with maintaining good validity until the end of the storage period.

4. Conclusion

Finally, it could be clearly concluded that the extraction of natural red pigments (betalain) from red beetroots with acidified water (3%) is the best procedure used as it is more applicable, feasible, economic and safe for human consumption. Moreover, the yield of separated pigments as natural crude extracts was high. Also, the study proved that using the natural pigment extracted from beets added good and acceptable color to the candy throughout the storage period compared to the artificial color and it is noted that the best packaging material for Jelly candy is MTPP followed by PET box and MTPP+TPP at refrigerator temperature while HDPE package showed degradation in color and pigment decomposition especially at room temperature. So it could be recommended that those natural red pigments should be utilisés as natural colorants instead of artificial ones in coloring infant candy.

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