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Preparation of Harmless Play Dough with Some Vegetable Dyes

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ABSTRACT

Preparation of harmless play dough process with vegetable dyes were investigated using various plant extracts (pomegranate flower, onionskin, purple basil, spinach, walnut leaves, red beet, red cabbage, turmeric, Turkish coffee, woad and red pepper) and powders of some plants (woad and Turkish coffee) as direct dye. Play doughs were obtained with plant extract. For this purpose, processed wheat flour with powders of plants by using kneading method with combination of various adjuvants were used. Decay times at room and cold ambient temperatures were determined. Texture and glutomatic system analysis were done for the investigation of the elasticity and elongation features. Prepared play doughs were used as a practical in order to understand whether they show any allergen status during and after play in kindergarten and nursery. The play dough obtained from unheated method was conquered to the other methods based on their properties of both color and longevity.

1. Introduction

Toys are defined as anything that can be played and enjoyed in dictionaries [1]. Toy, which improves the imagination and creative abilities of the child during the stages of development, bringing order to the movements of the child, helping the mental, physical and psycho-social development [2].

For the pre-school children tools play a role that allow them to reflect their world in a pure and simple way. In this sense, games such as hawks and legos are more likely to support children in acquiring skills in different fields [3].

Today, toys are very diverse. They can be made of different materials, different colors and different properties. But the best toy is the toy that the child will want to play again and again and every time it gives him more games and more fun. The toy should raise curiosity in the child, run the muscles, and direct the child to solve the problem [4, 5].

While playing with the toy, it can often face various hazards, especially health problems, by taking the toy to the mouth. For this reason, the materials that are produced and the paint used become even more important in terms of health. Dyes are used to obtain a different color of materials, to obtain aesthetic images [6].

The earliest known story of production of hawks in literature was started in 1955. Inventors N.W. McVicker is Joe McVicker (1929-1992). The product is one of the most popular toys; on the one hand, one of the most interesting inventions [7]. Play-Doh, a game hood for children, 95 million boxes sold in 75 countries, was first produced for wallpaper cleaning. Play-Doh is a modeling material that young children use at home and at school in their handicrafts or artwork [8]. Joe McVicker and N.W. On May 17, 1960, they took the patent of Play-Doh's last formula.

In this study, we aimed to prepare the harmless play dough using some vegetable extracts. For this purpose, we used wheat flour, some vegetable extracts and auxiliary materials such as clay and tragacanth. As a result, we obtained harmless play dough for children.

2. Experimental Methods

2.1 Materials

Experimental studies were carried out in the Tokat Gaziosmanpasa University, Natural Dyes Application and Research Center laboratory (Tokat-Turkey).

In this work, heat-resistant container for extraction, soxhlet device, solid fruit juice for working with cold pressing method, Marshall 1001 Color Hopper for color codes, digital pH meter for measuring the pH value of the environment, a steel cup for mixing dough, suitable for measurement, storage bin, beaker in various dimensions and beakers, analytically sensitive scale, thermostat heater, color measurement spectrophotometer, scale adjustable refrigerator for the storage of samples in appropriate temperature environment, plants were used. White-yellow clay, rose water, vegetables and fruits were supplied from the markets established in Tokat city center. Wheat flour, salt, liquid vegetable oil, dry and wet yeast, grape juice, lemon juice and carbonate were taken from markets.

2.1.1 Properties of Used Materials

Lemon water: Kavaklıdere brand lemon juice is used.
Turkish coffee: Gold Reyan Turkish coffee is used.
Liquid vegetable Oil: Cooperative refined sunflower oil is used.
Processed wheat flour: Birsan flour was used.
Wet yeast: Pakmaya brand yeast was used.
Dry yeast: Pakmaya brand active dry pasta is used.
Grape circle: Doğanay brand grape circus is used.
Sample box: A sample volume of 100 mL volume of Fıratmed brand was used.
*Rose wate*r: Waterfall brand non-alcoholic rose water is used.
Carbonate: Dr. Oetker brand carbonate is used.
Reference Play dough: Play-Doh brand 4-player game hamper is used.
Cooking salt: Billur salt brand cooking salt is used in fine salt.
Kneading boiler: A steel vessel is used for sterility.
Marshall 1001 color hopper: Used in the color coding phase

2.2 Method

2.2.1 Obtaining of the Play Dough

The methods of thermal heat treatment and clay application are taken from sites that take advantage of organic production and consumption [9]. The other 5 methods have original formulations.

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2.3 Preparation of Materials

a) Preparation of Walnut Leaf Extract: 250 g of Walnut leaf were boiled in 2 L of pure water for 1 hour. The obtained extract was used as a dye solution for coloring.

b) Preparation of Pomegranate Extract: 100 g of pomegranate flower was boiled in 1 L of pure water for 1 hour. The obtained extract was used as a dye solution for coloring.

c) Preparation of Turmeric Extract: 10 g of Turmeric powder was extracted in soxhlet device with 4 separate cartridges until the solution of 2 L was obtained with distilled water until colorlessness at boiling temperature. The obtained extract was used as a dye solution for coloring.

d) Preparation of Red Beet Extract: 3 kg of Red beet was boiled in 3 L of pure water for 1 hour. The obtained extract was used as a dye solution for coloring.

e) Preparation of Red Cabbage Extract: 1 kg of grated Red cabbage in 2 L purified water was boiled for 1 hour. The obtained extract was used as a dye solution for coloring.

f) Preparation of the Spinach Extract: The spinach juice obtained by passing 2 kg of the spinach cold pressing method was heated for 15 minutes and used as a paint solution.

g) Preparation of Indigo Extract: 10 g of powdered civitus was extracted with distilled water and 30 mL vegetable oil were extracted until a 3 L solution was obtained at the boiling temperature until colorless. The obtained extract was used as a dye solution for coloring.

h) Preparation of Purple Reed Extract: 10 g of Purple red was extracted in distilled water in soxhlet device. Extraction was continued until 2 L solution until to colorlessness. The obtained extract was used as a dye solution for coloring.

ı) Preparation of Coffee Extract: 10 g of coffee was extracted in the soxhlet machine with 4 separate cartridges, until the 2 L solution until the colorlessness. The obtained extract was used as a dye solution.

ı) Preparation of Red Pepper Extract: 2 kg grated Red pepper was boiled in 4 L of distilled water for 1 hour. The obtained extract was used as a dye solution for coloring.

j) Preparation of Onion Skin Extract: 50 g of Onion skin was boiled in 3 L of pure water for 1 hour. The obtained extract was used as a dye solution for coloring.

k) Preparation of the Carbonate Solution: 10 g of sodium hydrogen carbonate was dissolved in 1 L of purified water and measured at pH 8.61.

2.4 Painting Methods

a) Heat Treatment: After mixing 60 g of processed white wheat flour, 3 ml of liquid vegetable oil, 10 g of food salt, 3 mL of grape juice, 40 mL of extraction solution in a suitable heat-resistant container was heated at 60 °C for 5 min. The mixture was taken from the container through the heater when it was easy to leave. It was kneaded and left to cool for a homogenous image. It was kept airtight after the cold.

This staining method was used in the same way for 11 plants. For direct dusting of indigo grass and cabbage; 50 g of processed wheat flour, 3 mL of liquid vegetable oil, 10 g of food salt, 3 mL of grape juice, 30 mL of pure, 5 g of indigo or coffee water were mixed in a bowl and then stirred on a heater at 60 °C for 5 minutes. The mixture was taken from the container through the heater when it was easy to leave. It was kneaded and left to cool for a homogenous image. It was kept airtight after the cold. At the end of all applications, 13 different colors of game dough were obtained.

b) Without Heat Treatment: 60 g processed white wheat flour, 2 mL liquid vegetable oil, 10 g meal salt, 30 mL extraction was mixed and kneaded with hand. It was left to rest when it was a very hard and not very soft consistency 10 min. This painting method uses 11 plants. For direct dusting of indigo grass and cabbage; 50 g processed wheat flour, 3 mL liquid vegetable oil, 10 gr food salt, 30 mL pure water and 5 g indigo grass dust or coffee are mixed in a convenient container and knead with hand. It was left to rest when it was a very hard and not very soft consistency. 13 different colors of game dough were obtained.

c) Using Clay: 40 g of processed white wheat flour, 20 g of white-yellow clay, 3 mL of liquid vegetable oil, 10 g of food salt, 45 mL of extracting paint solution are mixed in a suitable container and then kneaded by hand. It was left to rest when it was a very hard and not very soft consistency. Finally, it was kept airtight after 10 minutes of rest. This staining method was used identically for 11 plants. For direct dusting of indigo grass and cabbage; 40 g of processed white wheat flour, 20 g of white-yellow clay, 3 ml of liquid vegetable oil, 10 g of food salt, 50 ml of purified water, 5 g of indigo powder or coffee were mixed in a suitable container and then kneaded by hand. It was left to rest when it was a very hard and not very soft consistency. It was kept airtight after 10 minutes of rest. At the end of all applications, 13 different colors of game dough were obtained.

2.5 Color codes

The color codes of play doughs obtained using all methods were made using the Marshall 1001 Color Hopper.

2.6 Color Analysis

The obtained samples were made using D65 light source and 10° measurement angle using SS 6200 spectrophotometer.

2.7 Manuel Gluten Review

The reference game hawthorn sold in the market and heat treatment were applied as 2x10 g separately from the game hawthorn samples obtained by the experiment using dry yeast, wet yeast, and the test. 4.8 mL of 2% NaCl solution was added onto the sample. The mixture is kneaded by slowly adding the washing solution. Care was taken to ensure that the dough particles formed during kneading did not stick to the edge of the cabinet and to the mortar. The obtained dough was kept between three fingers, flattened and then rounded again until the starch was completely removed. The wet gluten was washed under tap water for 2 minutes to completely remove the starch. At the end of the process, only gluten with elastic pasty consistency was obtained from the gypsum obtained by using wet yeast and urea.

2.8 Glutograph (Wet Gluten) Analysis

The glaucoma obtained according to the Manual Gluten Evaluation was waited for 5 minutes and put on the glutograph device. At the end of the measurement, the amounts of the play dough passing and not passing through the two separate disk were determined [10].

2.9 Dry Gluten Analysis

The game clone obtained in the age of gluten weighing was placed in the Glutork brand dry gluten-forming device. After waiting 4 minutes at 200 °C, dry gluten was weighed and the results were recorded [10].

2.10 Texture Analysis

Texture analyses of all the dough samples were carried out by SMS-TA XT device using SMS/Kieffer Doug and Gluten Extensibility Rig by applying the "dough and measure quality" method.

2.11 Allergy Application

The samples of the game clay obtained from all methods were applied by 12 students in Tokat/Turkey American Culture Day Care Center, Kindergarten and Nursery School affiliated to the Ministry of Family and Politics.

3. Results and Discussion

Experimental data (CIE Lab, K/S and Color Code) belong to play dough are given in using heat treated, unheat treated, clay and tragacanth in Tables 1-4 and Figs. 1-4. The color reproduction is in the play dough made with the highest for powdered coffee. The CIE Lab wave length of the play dough obtained with red pepper, turmeric and powder indigo was different and higher than the others.

Fig. 1 The color of the play dough obtained by heat treatment

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Table 1 By controlling heat treatment according to the pH of the play dough, pH, CIE Lab, K / S and color codes

Plant	pH	Color coordinate			K/S	Wavelength (nm)	Color code
		L*	a*	b*			
Spinach	5.55	67.758	-0.153	20.71	3.953	360	2020-G89Y
Purple reed	6.08	56.027	5.66	13.33	6.893	360	S 3010-Y40R
Red pepper	3.85	59.434	38.10	49.91	7.816	480	0766-Y58R
Turmeric	6.95	73.199	2.985	60.48	6.366	430	1056-Y01R
Red cabbage	4.03	43.315	15.86	-2.56	7.925	360	3527-R31B
Coffe powder	8.24	52.131	8.0380	23.200	11.74	360	5117-Y17R
Onion skin	6.22	65.970	8.0270	21.013	5.830	360	S 1010-Y30R
Pomegranate	2.54	34.469	17.598	3.4238	2.578	360	S 2030-R30B
Walnut leaf	6.7	69.329	2.7240	21.576	5.259	360	2910-Y09R
Red beet	3.55	44.490	22.531	0.2939	4.817	360	S 3040-R30B
Coffe powder	-	43.499	8.2721	18.574	15.737	360	5218-Y32R
Indıgo extract	8.21	53.399	-4.7529	-13.866	3.210	360	S 1040-R80B
Indigo powder	-	28.991	5.6653	-27.630	11.127	590	S 5040-R70B

13 different colors of organic game dough were obtained according to the method of obtaining play dough without heat treatment. The pH values before the treatment and CIE Lab, K/S and color code after the treatment are given in Table 2 and Fig. 2. As a result of this method, 13 different game doughs were obtained. The color reproduction is in the game dough made with the highest powdered coffee. The CIE Lab wave length of the game pulp obtained from red pepper, powder coffee and powder indigo is different and higher than others.

Table 2 Without heat treatment, pH, CIE Lab, K/S and color codes

Plant	pH	Color coordinate			K/S	Wavelength (nm)	Color code
		L*	a*	b*			
Spinach	5.55	62.5646	-0.0315	26.2197	5.7130	360	S2020-G80Y
Purple red	6.08	76.8850	1.9527	14.4811	3.1927	360	1108-Y19R
Red pepper	3.85	65.7368	33.618	48.7255	4.7775	460	0860-Y27R
Turmeric	6.95	78.3996	0.2707	53.5612	3.8324	360	1056-Y01R
Red cabbage	4.03	64.2704	4.6264	-1.4989	2.9823	360	3329-R46B
Coffe powder	8.24	66.2369	4.3183	17.7774	4.1305	360	2318-Y20R
Onion skin	6.22	77.1227	5.8187	20.1907	3.5520	360	0505-Y45R
Pomegranate	2.54	61.1304	12.5360	2.8980	3.3720	360	1905-Y86R
Walnut leaf	6.7	77.1227	2.9596	19.1740	3.3867	360	1008-Y10R
Red beet	3.55	69.4016	15.7919	9.8033	1.9929	360	1729-Y97R
Coffe powder	-	51.7886	8.3944	20.9555	8.3551	360	5218-Y32R
Indigo extract	8.21	57.7453	3.0469	20.7796	1.7159	360	S2050-R80B
Indıgo powder	-	37.2864	4.3727	-33.003	7.0568	590	3050-R75B

Fig. 2 Play dough colors obtained without heat treatment

13 different colors of organic play dough were obtained using clay. The pH values before the treatment and CIE Lab, K/S and color code after the treatment are given in Table 3 and Fig. 3. The play dough with the highest color yield was obtained with powdered coffee. However, the CIE Lab wavelength values are all the same.

Table 3 pH, CIE Lab, K/S and color codes using clay

Plant	pH	Color coordinate			K/S	Wavelength (nm)	Color code
		L*	a*	b*			
Spinach	5.55	60.2656	2.6071	23.495	6.19822	360	S2020-G80Y
Purple reed	6.08	54.8087	4.6057	13.392	6.65475	360	1108-Y19R
Red pepper	3.85	60.4451	17.5595	31.164	5.42485	360	0860-Y27R
Turmeric	6.95	68.5295	3.1375	29.194	4.56406	360	1056-Y01R
Red cabbage	4.03	44.3370	4.2491	-5.0413	6.06790	360	3329-R46B
Coffee extract	8.24	57.7069	2.8909	14.604	5.68654	360	2318-Y20R
Onion skin	6.22	51.2190	5.4975	11.749	7.34952	360	0505-Y45R
Pomegranate	2.54	51.5601	18.1163	3.9076	5.76663	360	1905-Y86R
Walnut leaf	6.7	62.4197	3.1607	16.921	5.8029	360	1008-Y10R
Red beet	3.55	55.8305	9.7245	13.952	5.7219	360	1729-Y97R
Toz Kahve	-	49.4506	5.2014	16.227	8.4605	360	5218-Y32R
Indigo extract	8.21	59.7100	-3.3329	4.4440	5.0266	360	S2050-R80B
Indigo powder	-	39.5524	-21.489	-21.489	5.6516	360	3059-R75B

Fig. 3 Play dough colors obtained using clay

13 different colors of organic game dough have been obtained using tragacanth. The pH values before the treatment and the CIE Lab, K/S and color code after the treatment are given in Table 4 and Fig. 4. The play dough with the highest color yield was obtained with powdered coffee. The CIE Lab wavelength value is different for powder indigo and it is only the highest value compared to the others.

Table 4 pH, CIE Lab, K/S and color codes using tragacanth

Plant	pH	Color coordinate			K/S	Wavelength (nm)	Color code
		L*	a*	b*			
Spinach	5.55	58.122	1.9310	28.059	5.532	360	S3020-G90Y
Purple reed	6.08	66.433	1.8284	12.893	3.801	360	S1005-Y30R
Red pepper	3.85	74.415	24.109	39.727	1.8995	360	0540-Y46R
Turmeric	6.95	83.325	-2.905	33.096	1.7549	360	0430-G90Y
Red cabbage	4.03	59.604	1.7937	6.9998	4.5221	360	2105-R52B
Coffee extract	8.24	75.996	3.7867	19.273	2.7793	360	1206-Y17R
Onion skin	6.22	75.674	4.5168	16.098	2.8511	360	S1005-Y50R
Pomegranate	2.54	57.523	5.1089	5.5413	3.8144	360	3908-Y96R
Walnut leaf	6.7	73.700	2.8347	16.198	2.5994	360	1108-Y19R
Red beet	3.55	74.425	4.9333	8.948	1.5381	360	0605-Y76R
Coffee powder	-	40.222	9.7239	18.214	15.517	360	6022-Y33R
Indigo extract	8.21	76.253	4.5162	-4.331	0.9459	360	0818-R86B
Indigo powder	-	33.495	6.0341	-32.62	8.8679	590	4447-R81B

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Fig. 4 Game hood colors obtained using tragacanth

3.1 Texture Analysis

The texture analysis graphic of play dough obtained from without heating is given in Fig. 5.

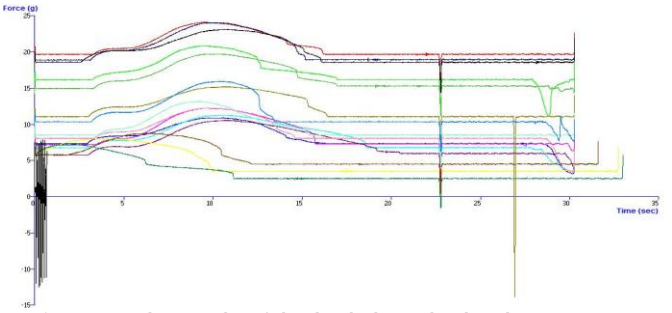


Fig. 5 Texture analysis graphic of play dough obtained without heat treatment

For the play dough obtained without heat treatment, each color shows the same sample but different pieces. According to the result of the sample, highest force value required to break the specimens was found to be 24,161 force (g). Distance (mm, the elongation to the breaking moment) was found to be 35.07 mm for the play dough obtained without heat treatment. The texture analysis of play dough obtained from by heat treatment are given in Fig. 6.

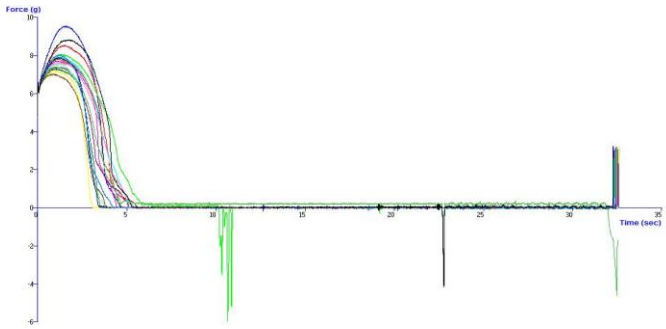


Fig. 6 Texture analysis graphic of the play dough obtained by heat treatment

For the play dough obtained by heat treatment, each color shows the same sample but different pieces. According to the result of the sample, maximum force to be applied for breaking of the samples was found to be 9,584 force (g). The distance (mm) was found to be 5,813 mm. The texture analysis graphic of the play dough obtained using clay is given in Fig. 7.

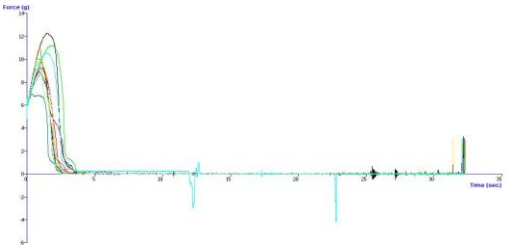


Fig. 7 Clay texture analysis of the game obtained using clay

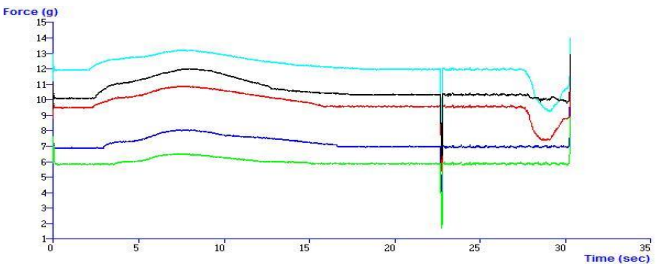


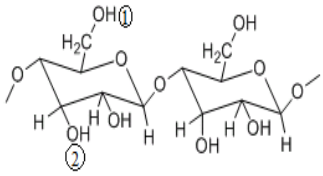
Fig. 8 The texture analysis graphic of the play dough obtained using tragacanth

For the game dough obtained using clay, each color shows the same sample but different pieces. According to the result of the sample, the highest force value to be applied for breaking the specimen was found to be 12,276 force (g). The distance (mm) was found to be 6,192 mm. The texture analysis graphic of the play dough obtained using tragacanth is given in Fig. 8.

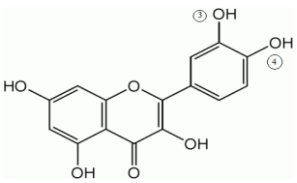
For the play dough obtained using the tragacanth, each color shows the same sample, but different pieces. According to the result of the sample, maximum force value required to break the specimen was found to be 14,075 force (g). The distance (mm) was found to be -0,183 mm. According to the results of the texture analysis of the obtained play dough, the Force (g) required to break the specimens and elongation distances (mm) up to the breaking moment is the highest for the play dough that obtained without heat treatment.

3.2 Interactions between Fiber Materials and Cellulose in Used Plants

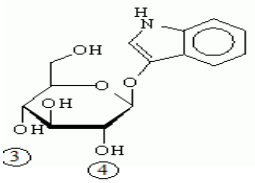
For bonding between cellulose and dyestuff molecule (Fig. 9), the H atoms release with interaction between the oxygen(3) in the quercetin molecule structure and the hydrogen(1) in the cellulosic structure, and again the oxygen(4) in the quercetin and the hydrogen(2) in the cellulosic structure [11].



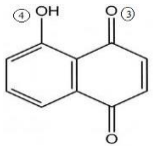
Molecule structure of cellulose



Quercetin(in Onion skin)



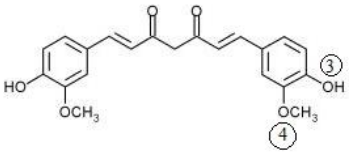
Indican (in the indigo grass)



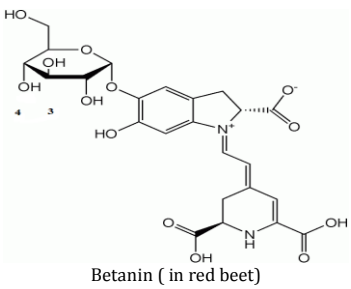
Juglon (in walnut)

Fig. 9 Chemical structures of cellulose and dyestuff molecules

Here too, the interaction occurs for giving chemical bond between the oxygen(3) in the indican molecule and the hydrogen(2) in the cellulosic structure, again the oxygen(4) in the indican and the hydrogen(1) in the cellulose. Similarly, chemical bonding occur between the O(3) and the H(1) in the cellulosic structure, again the O(4) of the juglon and the H(2) in the cellulose molecule [11].



Curcumin(in turmeric)



Betanin (in red beet)

Fig. 10 Structures of curucumin and betanin

As mentioned above, chemical interaction occures between the oxygen atom (3) in the curcumin and the hydrogen atom (1) in the cellulose, and again between the oxygen atom (4) of the cucumin and the hydrogen atom(2) in cellulose (Fig. 10).

For betanin, the interaction between the oxygen atom (3) of the molecular structure of the betanin and the hydrogen atom(1) of the cellulosic structure, and the oxygen atom (4) of the betanin and the hydrogen atom (2) of the cellulose cause to the chemical bonding.

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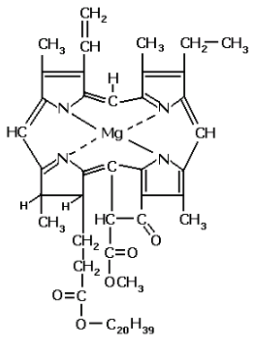
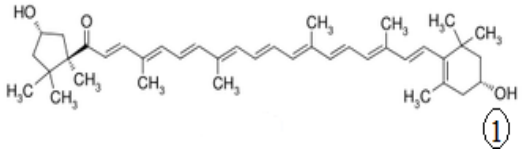


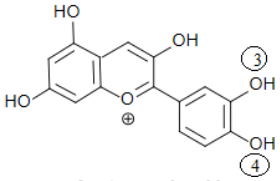
Chlorophyll a (in Spinach)



Capsanthin(in red pepper)

Fig. 11 Structres of chlorophyll a and capsanthin

It is believed that Van der Walls interactions between cellulose and chlorophyll a in the spinach coloring agent (Fig. 11). However, capsanthin which is in the red pepper is the coloring matter found in the structure of the plant. Similarly, It is predictable that Van der Walls interactions between cellulose and capsanthin molecule. The interaction occurs between the oxygen(1) in the structure of the capsanthine molecule and the hydrogen number 1 or 2 in the cellulosic structure. Cyanidin is found in purple cabbage, pomegranate flower, purple coloring.



Cyanidin (in Purple cabbage)

Fig. 12 Structure of cyanidin

For cyanidine (Fig. 12), chemical bonding also occurs between the oxygen(3) of the cyanidyne molecule and the hydrogen(1) of the cellulose, and again the oxygen(4) of the cyanide and the hydrogen(2) of the cellulosic structure[11].

3.3 Application on Nursery Children

Playing doughs that ready to use were applied by 12 students (4-6 age years old) in the Tokat American Culture Day Care Center, affiliated to the Ministry of Family and Politics (Tokat/Turkey). We have not been notified of any signs or symptoms of allergy by the students and the parents within the next day and within 1 week after the smell of the samples is not disturbed.

The resulting doughs were stored in two separate parts of the refrigerator. The first deterioration in the samples stored at 4 °C at the lower refrigerator temperature occurred after 119 days, the upper refrigerator temperature - at 18 °C the first deterioration occurred after 186 days. The first deterioration occurred 12 days after the samples were kept closed at 20-22 °C in room conditions. In the samples left with open mouth, it was completely dried at the end of the 3rd day with the crust on the upper surfaces at the end of the first day.

If evaluated in terms of odor, it was observed that there was a sharp smell in the play doughs obtained with purple cabbage. In this sense, rosewater was used as an essence to eliminate smell and there was a decrease in smell perceived.

When all methods are analyzed we can say that if the first choice is color we may use the play doughs obtained unheated methods; if the first choice is to use a long time, we may use play doughs obtained from tragacanth.

4. Conclusion

When all the study results are evaluated, it is the stage of maximization of the deterioration period at the point room conditions where the project should be developed or supported. It is thought that the bay leaf used to extend the decay time of the foodstuff can be extended for only 2-3 days but this time is not enough. The pungent smell of some plants or fruits may be disturbing to the person/persons using the dough. In this sense, research and development should be done in such a way that the naturalness of the formulation does not deteriorate in order to eliminate the smell of the plants. It is thought that because of its organic nature, its ingredients are not harmful to health, and that the play doughs we produce today, which our families and all humans avoid from synthetic products, will appeal to large masses.

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