# STUDY OF PHYSICAL PROPERTIES OF PLAY DOUGH

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**Abstract**

This study has objectives to 1) To study physical properties of play dough prepared from corn flour mixed with rice flour 0-50% e.g. color and texture 2) To evaluate acceptance test from consumers aged 8-12 years and 19-22 years. Instruments which were used in experiments e.g. RVA, Texture Analyzer, and Hunter Lab Colorimeter. From the results, the researchers found that the more rice flour content in play dough, the lower pasting temperature. From color measurement results, the higher rice flour content in mixed flour play dough, the brighter score ($L^*$). Since rice flour is brighter than corn flour. Rice flour play dough at 0% and 50% has $L^*$ 73.20 and 78.52, respectively. From acceptance test in Hedonic scale 0-9, the researchers found that children aged 8-12 years evaluated rice flour play dough at 0% and 30% at 8.28 and 7.80, respectively which were not significantly different in statistics. However, acceptance test scores in texture test showed that 0% rice flour play dough has the higher score than 30% rice flour play dough. The higher rice flour content, the higher stickiness with hands.

**Keywords: Play Dough / Rice Flour / Corn Flour / Physical Properties**

## Introduction

Celiac disease is an autoimmune disorder that can occur in genetically predisposed people where the ingestion of gluten leads to inflammation at small intestine. When people with celiac disease consume foods containing gluten, their immune system will damage the villi in small intestine. The symptoms of celiac disease are included growth problems, vomiting, fatigue, abdominal bloating and pain, chronic

diarrhea, decreased appetite, irritability, etc. Celiac disease patients have to lifelong strict on gluten free diet. However, celiac disease affects people differently. Some people with celiac disease are sensitive to low level of gluten. They can't touch gluten foods or utensils that are contaminated with very small amount of wheat flour. Some people develop celiac disease as children, others as adults. Children who are sensitive to gluten would allergic when touch wheat play dough.

Play dough is a homemade non-toxic toy prepared from natural ingredients e.g. wheat flour, salt, cream of tartar, food grade colors and fragrances. The preparation of play dough is included cooking in a pan and kneading the mixture until the mixtures are thoroughly cooked and mixed. Gluten free play dough is normally prepared from corn flour, rice flour or tapioca flour. Thailand has a tradition of rice production. Thailand is the top 5 rice exporter in the world. Rice is the staple food in Thailand. The application of rice flour in non-food products would increase values of rice flour in the local and world market. Rice flour has a potential to make gluten-free play dough in order to substitute for wheat flour. The objectives of this study are to study physical properties of play dough prepared from corn flour mixed with rice flour 0-50% and to evaluate acceptance test from consumers aged 8-12 years and 19-22 years.

**Objectives of This Study**

1. To study physical properties of play dough prepared from corn flour mixed with rice flour 0-50%.
2. To evaluate acceptance test from consumers aged 8-12 years and 19-22 years.

**Scope of the Research**

1. Population scope

This research is aimed to produce gluten-free play dough for customers aged 8-12 years and 19-22 years.

2. Parameter scope

The scope of research is to use corn flour and rice flour in concentration 0-50% to substitute wheat flour.

3. Time scope

This study was done during October 2014 – August 2015.

**Literature Review**

Play dough consists of wheat flour, salt, cream of tartar, vegetable oil, water, colors and fragrances. It is simple to make at home. Play dough is suitable for kid arts because it has a soft texture. Small muscle in young children can be improved by playing play dough. Handwriting skill requires mastery of multiple skills, including small muscle development, eye-hand coordination and ability to hold pencil. Play dough is useful to use as a learning tool in school (Herur, Kolagi, Chinagudi, Manjula and Patil, 2011). Corn flour and rice flour can be used to substitute wheat flour for non-wheat diets in celiac disease patients (Demirkesen, Mert, Sumnu, and Sahin, 2010). However, rice flour has low elasticity and low shear force resistant. Texture of rice flour noodles can be improved by mixing with hydrocolloids e.g. xanthan gum, locust bean gum, and oat bran (Cham and Suwannaporn, 2010). The addition of hydrocolloids increased water holding in dough. Heat moisture treatment at 110°C for 15 hr. improved the texture of rice noodles (Cham and Suwannaporn, 2010; Hormdok and Noomhorm, 2007).

The addition of many kinds of flour could improve texture of gluten-free pasta (Ferreira and et.al., 2016). They investigated the use of mixed flour e.g. sorghum, rice, corn and potato at different ratios. Witczak and et.al. (2012) studied the influence of chemically modified starches and high amylose corn starch on the rheological and thermal properties of gluten-free dough based on corn and potato starches. In gluten-free breadmaking process, the addition of hydroxypropylmethylcellulose (HPMC) or β-glucan can mimic gluten viscoelastic properties in bread (Ahlborn, Pike, Hendrix, Hess, & Huber, 2005; Ronda,Perez-Quirce, Lazaridou and Biliaderis, 2015). The effect of concentration of β-glucans on rice-based doughs and bread characteristics was studied to improve texture properties of gluten-free bread (Ronda, and et. al., 2015)

**Research Methodology**

Rice flour was purchased from Bangkok Inter Food Co., Ltd., Bangkok. Corn flour was purchased from Continental Food Co., Ltd., Bangkok. Cream of tartar was purchased from Great Hill company, Bangkok. Salt was bought from Saha Pathanapibul Public Co., Ltd., Bangkok. Soybean vegetable oil was bought from Thai Vegetable Oil Public Co., Ltd., Bangkok.

Preparation of Play Dough and Pasting Temperature Measurement

The ratio of rice flour with corn flour (dry weight) was 10:90, 20:80, 30:70, 40:60, and 50:50 respectively to prepare rice flour at 10%, 20%, 30%, 40%, and 50% in this study. The concentration of

mixed flour was controlled at 30% in saline solution. Cream of tartar was mixed with flour at 2.5%. Saline solution was composed of 50 g salt, 5 ml soybean vegetable oil, and 190 ml distilled water. Flour mixture was pour into a canister 7.5 g (dry weight). Saline solution was pour into a canister and make up weight to 25 g. Dough samples were cooked in a Rapid Visco Analyzer (RVA-TecMaster, Perten Instruments, Sweden) for 3.80 min. The heating rate in RVA was set as the following: 50°C for 1 min and 50-95 °C for 3 min. Heating process was terminated at 3.80 min for all samples. Pasting temperature was measured by using Thermocline for Windows (TCW) software. Sample was cooled down at room temperature in an ice bath. Play dough was shaped in a plastic mould (diameter 3 cm x height 2 cm) and kept in a plastic box before texture measurement.

Color Measurement of Play Dough

Color measurement of play dough was done by using Hunter Lab colorimeter (USA), Color Quest XE model with 2.5 cm aperture. Day light (D65) was used as the light source in this study. Reflectance method was selected with 2° angle. The CIELAB ($L^*$, $a^*$, $b^*$) was used to evaluate play dough color. When a color is expressed in CIELAB, $L^*$ defines lightness, $a^*$ denotes the red/green value and $b^*$ implies the yellow/blue value. Play dough was placed on the aperture of a colorimeter. Day light 65 was used to find reflectance of samples. Data was analyzed using HunterLab Universal software.

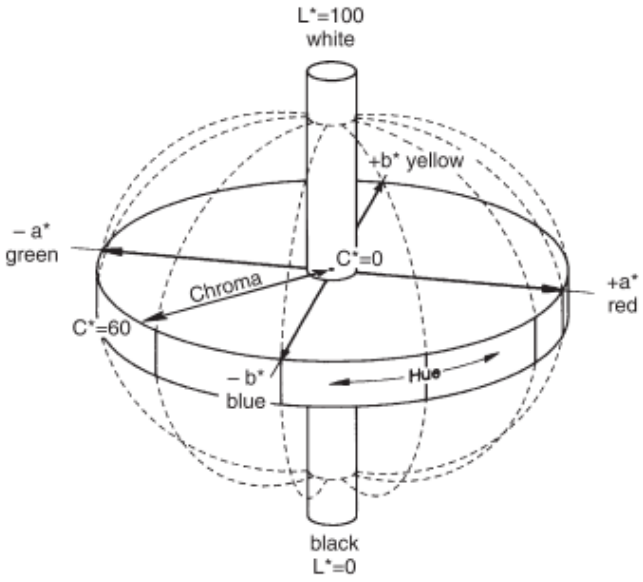


Figure 1. The L* value is represented on the center axis (0-100). The a* and b* axes appear on the horizontal plane.

(Ref: https://www.xrite.com/documents/literature/en/L10-001_Understand_Color_en.pdf)

Texture Analysis of Play Dough

Texture Analyzer (Lloyd Instruments, TA plus, Hants, UK) with 50 kN sensor was used in this study. Cylindrical probe with diameter 45 mm was attached to a sensor. Play dough sample was put at the center of a stainless plate. Compression measurement was run at velocity 5 mm/s and compression distance at 50% of sample height (20 mm). Texture data was determined as the following: hardness, cohesiveness, adhesiveness, springiness and fracture force.

Sensory Evaluation

Acceptance test in Hedonic scale 0-9 was scored with panelists in aged 8-12 years and 19-22 years for acceptance of texture and color. Play dough samples (80 g) were served in plastic cups labeled with random 3 digit codes. Fifteen panelist of each group in aged 8-12 years and 19-22 years were requested to evaluate color of play dough without touching for color evaluation. Moreover, they were touched play dough samples for texture evaluation.

Statistical Analysis

Statistical analysis was performed by using SPSS program version 20. Turkey's test was applied to find the significantly difference of parameters ($p < 0.05$).

**Results**

Table 1 Color measurement results of play dough

| Flour | Rice (%) | L* | a* | b* |
|---|---|---|---|---|
| Rice | 0 | 73.20$^{d}$±2.31 | -2.79$^{c}$±0.39 | 10.07$^{f}$±0.92 |
| Rice | 10 | 77.02$^{ab}$±1.10 | -2.90$^{c}$±0.18 | 11.90$^{f}$±0.25 |
| Rice | 20 | 77.50$^{ab}$±0.99 | -2.32$^{c}$±0.31 | 12.79$^{e}$±0.27 |
| Rice | 30 | 77.47$^{ab}$±1.98 | -2.20$^{c}$±0.16 | 13.12$^{d}$±0.40 |
| Rice | 40 | 76.94$^{ab}$±1.40 | -2.08$^{c}$±0.20 | 13.47$^{d}$±0.30 |
| Rice | 50 | 78.52$^{a}$±2.34 | -1.98$^{c}$±0.15 | 13.54$^{c}$±0.44 |
| Wheat Control | 0 | 75.75$^{c}$±1.16 | -0.11$^{b}$±0.16 | 11.88$^{e}$±0.32 |
| Wheat A | 0 | 62.97$^{d}$±22.25 | 5.33$^{a}$±3.85 | 25.42$^{a}$±3.96 |
| Wheat B | 0 | 54.76$^{f}$±18.11 | 5.38$^{a}$±2.84 | 22.42$^{b}$±2.13 |
| Wheat C | 0 | 51.43$^{e}$±14.47 | 4.05$^{a}$±2.19 | 18.39$^{c}$±3.11 |
| Wheat D | Sample D | 63.19$^{d}$±14.37 | 2.07$^{a}$±3.13 | 27.88$^{a}$±3.40 |

Table 2 Pasting temperature measurement of play dough

| Rice Concentration (%) | Viscosity (cP) | Pasting Temperature (°C) |
|---|---|---|
| 0 | 3964.00$^{a}$±2107.88 | 80.53$^{a}$±0.61 |
| 10 | 2608.33$^{ab}$±1462.76 | 80.43$^{a}$±0.68 |
| 20 | 1894.00$^{b}$±647.96 | 80.02$^{ab}$±0.31 |
| 30 | 1438.83$^{b}$±490.75 | 79.48$^{b}$±0.71 |
| 40 | 2333.17$^{b}$±1342.17 | 78.53$^{c}$±0.46 |
| 50 | 2829.00$^{ab}$±659.13 | 77.20$^{d}$±0.43 |

Table 3 Texture measurement results of play dough

| %Rice | Hardness (N) | Cohesiveness (mm) | Springiness (kgf) | Fracture force (N) | Adhesiveness (kgf·mm) |
|---|---|---|---|---|---|
| 0% | 76.55$^{c}$±17.79 | 0.12$^{b}$±0.04 | 5.89$^{cb}$±2.41 | 6.16$^{ab}$±3.52 | 0.34$^{d}$±0.49 |
| 10% | 79.00$^{cb}$±5.78 | 0.07$^{cb}$±0.03 | 5.05$^{ce}$±2.67 | 7.64$^{a}$±0.65 | 0.12$^{d}$±0.08 |
| 20% | 77.18$^{c}$±11.72 | 0.08$^{cb}$±0.04 | 4.64$^{cde}$±0.89 | 7.45$^{a}$±1.26 | 0.41$^{d}$±0.31 |
| 30% | 72.89$^{c}$±10.03 | 0.08$^{cb}$±0.02 | 4.44$^{cde}$±0.60 | 6.05$^{ab}$±3.12 | 0.74$^{d}$±0.66 |
| 40% | 74.57$^{c}$±7.00 | 0.05$^{cb}$±0.03 | 5.10$^{ce}$±2.53 | 7.09$^{ab}$±0.74 | 0.86$^{d}$±0.45 |
| 50% | 57.99$^{ed}$±9.18 | 0.03$^{c}$±0.06 | 3.59$^{cde}$±1.19 | 5.34$^{b}$±0.87 | 0.77$^{d}$±0.30 |
| Wheat Control | 49.57$^{ef}$±1.23 | 0.03$^{c}$±0.03 | 3.98$^{cde}$±2.97 | 3.37$^{c}$±1.67 | 0.92$^{d}$±0.45 |
| Wheat A | 68.98$^{f}$±15.30 | 0.04$^{c}$±0.06 | 4.18$^{e}$±2.68 | 0.06$^{d}$±0.02 | 5.11$^{b}$±2.86 |
| Wheat B | 103.15$^{b}$±13.73 | 0.00$^{c}$±0.02 | 3.45$^{ed}$±0.54 | 0.08$^{d}$±0.01 | 1.45$^{d}$±1.05 |
| Wheat C | 70.11$^{d}$±9.53 | 0.19$^{a}$±0.16 | 7.63$^{a}$±2.92 | 5.46$^{b}$±2.75 | 4.07$^{c}$±1.48 |
| Wheat D | 236.31$^{a}$±25.22 | 0.03$^{c}$±0.01 | 6.36$^{ab}$±1.84 | 0.28$^{d}$±0.13 | 6.49$^{a}$±3.55 |

Table 4 Acceptance test for color of play dough

| Age (year) | 0% Rice | 10% Rice | 20% Rice | 30% Rice | 40% Rice | 50% Rice |
|---|---|---|---|---|---|---|
| 8-12 | $8.28^{a}\pm1.14$ | $6.96^{ab}\pm1.46$ | $7.68^{ab}\pm1.55$ | $7.80^{a}\pm1.51$ | $7.68^{a}\pm1.48$ | $6.84^{ab}\pm2.01$ |
| 19-22 | $7.32^{a}\pm0.95$ | $6.78^{a}\pm0.67$ | $7.14^{a}\pm1.29$ | $6.48^{a}\pm0.97$ | $7.14^{a}\pm1.50$ | $6.66^{a}\pm1.51$ |

Table 5 Acceptance test for texture of play dough

| Age (year) | 0% Rice | 10% Rice | 20% Rice | 30% Rice | 40% Rice | 50% Rice |
|---|---|---|---|---|---|---|
| 8-12 | $7.89^{a}\pm2.56$ | $6.46^{a}\pm3.00$ | $6.55^{cb}\pm2.33$ | $6.86^{ab}\pm2.63$ | $5.75^{c}\pm3.15$ | $6.70^{ab}\pm2.74$ |
| 19-22 | $6.83^{a}\pm2.25$ | $6.36^{a}\pm2.45$ | $6.23^{a}\pm2.14$ | $5.86^{b}\pm2.70$ | $1.94^{b}\pm2.29$ | $6.52^{a}\pm2.45$ |

**Discussion**

Pasting Temperature And Color Measurement of Play Dough

L* indicates the brightness of samples (0-100). From color measurement results, the higher rice flour content, the higher $L^{*}$ value. Wheat samples (A-D) are commercial play dough that are used to compared with our play dough samples. Sample A-D have the lower L* when compared with our play dough. However, they have higher $a^{*}$ and $b^{*}$ values. $a^{*}$ shows the red/green value. b* implies yellow/blue value. The higher levels of rice flour, the higher levels of yellow in play dough.

From pasting temperature results in Table 2, play dough at high concentration of rice flour shows lower pasting temperature. Since, rice flour has lower pasting temperature compared with corn flour. From viscosity results in Table 2, rice flour play dough at high rice concentration shows the trend of lower viscosity. Since, rice flour has no gluten. The viscosity and elasticity of dough decreased when rice flour is used to substitute wheat flour.

Texture Measurement of Play Dough

From texture measurement results in Table 3, wheat dough has lower hardness, springiness and fracture force when compared with gluten-free play dough. However, hardness decreased dramatically when rice flour added to flour mixture at 50%. Moreover, 50% rice flour play dough is easily stick to hands and has too soft texture. Commercial play dough (wheat B and D) have very high hardness values (103 – 236 N) compared with rice flour play dough (58-79 N) in our study.

Acceptance Test for Color and Texture

The most widely used scale (0-9) for measuring food acceptability is the 9-point hedonic scale. Score 0 means dislike extremely. Score 5 means neither like nor dislike. Score 9 means like extremely. Acceptance test for color from panelist aged 8-12 years shows that the colors and texture at 0-50% rice flour are not significantly different. However, acceptance test scores of color and texture test shows that 0% rice flour play dough has the higher score than 30% rice flour play dough. Panelists aged 19-22 years could distinguish 0% rice flour play dough with 30% rice flour play dough.

**Suggestion**

Rice flour should be added to corn flour at 30% concentration in order to have a good color and texture properties for customers aged 8-12 years and 19-22 years.

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