Some physiochemical and rheological properties of prepared spreadable tofu blends

By

Shafika A. Zaki
Department of Food Science, Faculty of Agriculture, Cairo University, Giza, Egypt.

Hala M. Nagi
Department of Food Science, Faculty of Agriculture, Cairo University, Giza, Egypt.

Abeer F. Zayan
Dairy Research & Technology Department, Food Tech. Res. Inst., Agric. Res. Center, Egypt

Amira S. Abd-Elsalam
Dairy Research & Technology Department, Food Tech. Res. Inst., Agric. Res. Center, Egypt
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Shafika A. Zaki* Abeer F. Zayan**
Hala M. Nagi * Amira S. Abd-Elsalam**

Abstract

Recently, the use of soy and soybean products has been grown in food industry. The study objective of the research is to prepare products of spreadable tofu with different flavors. Six formulated spreadable tofu with different flavors were prepared; control without addition, and with chopped green olives, ground black pepper and chopped green peppers; sugar; guava pulp, and peach pulp. The spreadable Tofu blends were subjected to chemical and sensory evaluation to ensure different qualities. L values were decreased with adding fruit, vegetable and spices to tofu. It took 80.16, 79.37, 76.12, 79.28, 75.70 and 75.40 for control, T1, T2, T3, T4 and T5 in respective order. The same trend was observed of A value and B values were increased, while yellowish was decrease because of tofu. Obtained data showed that meltability value in control, T1, T2, T3, T4 and T5 ranged (49-72), (33-55), (42-53), (35-71), (32-70) and (31-70), respectively. The control showed the highest value compared to other treatments. Texture properties of spreadable tofu blend indicated that the ranges of hardness presented (1.2- 8.4N), cohesiveness (0.19-0.63), springiness (2.48-8.00mm), gumminess (0.6-2.6N) and chewiness (3.69-12.66m.j). The highest hardness values was treatment T4 which contain tofu with 20% guava pulp compared to control and other treatments.

Key words: spreadable tofu, texture properties, guava pulp, peach pulp, green peppers, black peppers, green olives.
**Introduction:**

Soybeans have been primarily consumed by humans after being fermented and turned into a curd. Tofu, a bland, cheese-like substance made from the whey of fermented soybeans, is the most common example of this kind of soy-product. Bolla (2015) assured that soybeans are high in quality protein soybeans contain all the essential amino acids, in adequate amounts needed for health and two- three servings of soy provide ~15-20 g protein.

Tofu appeared to be the most popular among all soy products and also called soy bean curd. It has been made by coagulating hot soymilk with some food grade chemicals such as calcium chloride, magnesium chloride, calcium sulfate, acetic acid and citric acid (Mchugh, 2016).

The two most commonly used salt coagulants were calcium sulfate (gypsum) and magnesium chloride combined with calcium chloride (nigari salts) as reported by Rekha and Vijayalakshmi (2013) and Kang et al. (2014).

Vegetables and fruits seemed to be high in fiber and contain many vitamins and minerals as well as hundreds of beneficial plant chemicals (phytochemicals). Diets rich in vegetables and fruit could benefit the heart by lowering blood pressure, cholesterol levels, and inflammation and improving insulin resistance and blood vessel function and weight gain, a lower risk of stroke (Slavin and Lloyd, 2012 and Willett, et al., 2013).

Guava, a popular fruit of tropical and subtropical countries, contained 80% moisture 20% dry matter, 1% ash, 0.7% fat and 1.5% protein (Chauhan, et al., 2014). The utility of guava as functional foods have been increasing with the main traditional use preferred as an anti-diarrheas agent for treatment of gastroenteritis, dysentery, stomach, antibacterial colic pathogenic germs of the intestine, other medicinal properties of guava includes treatment of diabetes, hypertension, inflammation etc. (Metwally, et al., 2010).

Chauhan, et al. (2014) and Lim, et al. (2011) noted the preference of fresh fruit for consumption but seasonal availability limits consumption
of fruit throughout the year. Hence processed products such as puree, paste, canned slices in syrup or nectar are developed and marketed.

Peaches, considered among the first 3-5 fruit species regarding flavor and complex chemical composition, comprised of 10.0-21.5% dry matter, 5-12% total sugar, 0.4-1.3% protein, 0.2-0.7% pectin, 0.6-0.86% minerals and vitamins (Iordănescu and Micu, 2012).

Peppers, important vegetables, have been used fresh or as a spice (Marinova, et al. 2005 and Igbokwe et al., 2013).

Black pepper, one of the most popular spice products in oriental countries, has largely used as a flavoring agent in foods (Mueller and Hingst, 2013). The components of the pepper’s extract that contribute to its value as a food additive included the volatile oil for its aroma and the alkaloid compounds for the pungency (Brewer, 2011).

Olives as good source of several vitamins and minerals, some of which were added during processing, such as vitamin E, cholin, niacin, vit. A, B6, thiamin calcium, iron, and copper (Rines and Ardehali, 2013, Abbaspour et al., 2014, Emkey and Emkey, 2012 and Hui, et al. (2015).

In the last few decades, palm oil’s application in food industries has exponentially grown for the texture, the fragrance and the neutral taste it guarantees in the finished products. Its two major fractions consisted of the low-melting liquid fraction (known as palm olein, 65%–75%) and the high-melting solid fraction (known as palm stearin, 30%–35%) as reported by Henson (2012).

The present investigation aimed to study the effect of mixing tofu with some vegetables and fruits on some physiochemical and rheological properties of spreadable tofu products with different flavors.

**Materials and Methods**

**Materials**

a. Soybean seeds (Glycine Max., L., commercial variety) were obtained from Legumes Research Dep., Field Crops Research Institute, Agriculture Research Center, Giza, Egypt.
Some physiochemical and rheological properties of prepared spreadable tofu blends

b. Palm oil from Efico star Co. Egypt

c. Skimmed milk powder from Fonter ALTD; Auckland, New Zealand. Whey powder from Agropur Granby, Canada.

d. Emulsifying salt (Joha S9 special) from Arabian Food Industries Co. Egypt

e. green olives, ground black pepper, chopped green peppers, sugar; guava, peach salt (Nacl), from local market.

f. Stabilizers (corn starch, CMC, soluble starch, modified potato starch, Guar gum) from AVEBE U.A. The Netherlands.

g. Q3 {Sodiumcarboxymethyl Cellulose (E 466) - Gur gum (E 412)} stabilizer from BK Giuliani GmbH, Ladenburg, Germany.

Methods

Preparation of Tofu:

- Cooking soymilk in a steam jacketed kettle at 90-95°C for 15-20 min. (Groen, Adover Industries Co., Elk village, USA.

- Weighing 100 kg soymilk in bucket and reheat it at 85°C.

- Adding a warm coagulant powder (0.5 % calcium chloride) to soymilk at 70-80 °C with agitation using a paddle.

- After forming curd allowing it to stand for 15-20 min.

- Breaking up the curd evenly and transferring it using a ladle into a forming box lined with moistened cloth, and then covering the box with lid.

- Pressing with a suitable pressure (at 50 psi for 15-20 min.

- Placing the forming box with tofu in a cooling tank, resetting to the tofu for 5 min, unfolding the cloth and removing the tofu.

- Cutting the tofu into pieces (about 3×4 × 5 cm.

- Packing & Immersing tofu in plastic bags without any addition in chilled water (Benassi et al., 2011) and (Agrahar, 2014).
**Preparation of Spreadable tofu with some commodities**

The suitable amounts of raw materials (soy curd (Tofu), Skimmed milk powder, whey proteins, palm oil, Stabilizers {((Q3) Sodium carboxymethyl Cellulose + Guar gum), emulsifying salts and water were used for preparing spreadable tofu blends. The raw materials with added commodities and water were added consecutively in laboratory processing Kettle (Thermomix TM 31 made in Australia Pty Ltd 2010) as mentioned by Awad (2014). All blends were adjusted to contain 58% moisture, 50% fat/DM and 2.5% emulsifying salts (Joha S9 special). Some vegetable, fruits and spice were added to the formula as a substitute of tofu. The mixture was cooked for 10 min at 85-90°C using indirect steam at pressure 2-2.5 kg/cm2. The mixture was hot filled into wide mouth glass jars and capped directly after filling. The resultant spreadable tofu was analyzed when manufactured and after 1, 2 and 3 months of storage in refrigerator (5 ±2°C). The mixture was cooked for 10 min at 85-90°C using indirect steam at pressure 2-2.5 kg/cm2 then was hot filled into wide mouth glass jars and capped directly after filling. The spreadable tofu samples were analyzed at 0, 1, 2 and 3 months of storage in refrigerator (5 ±2°C).

Formulations of all the six tofu blends consisted of skim milk powder (50g), whey powder (30g), and emulsifying salts (25g). The other remaining commodities per 1000 g were different in the six prepared blends as follows:

Control (C): 454.75soy curd, 172.03Palm oil, 30Q3, 238.22 g water.
T1: 404.75soy curd, 170Palm oil, 35Q3, 50chopped green olives and 235.25 g water.
T2: 427.75soy curd, 176.45Palm oil, 38Q3, 0.2 % ground black pepper and 2.5% chopped green peppers and 235.25 water g.
T3: 434.75soy curd, 174Palm oil, 30Q3, 20 sugar and 236.35 g water.
T4: 404.75soy curd, 170Palm oil, 35Q3, 200Guava pulp and 77.69 g water.
T5: 404.75soy curd, 170 Palm oil, 35 Q3, 150 Peach pulp and 63.52 g water.
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**Physicochemical properties:**

- **Determination of meltability property**

  The meltability of blends was represented by the difference (Dt) between sample area at cooking time t (min) and that before cooking: $\text{Dt} = \text{At} - \text{A0}$; where At is the sample area (mm²) in t min cooking and A0 is the initial sample area (mm²). Meltability of spreadable tofu blend was tested as described by Wang and Sun (2002).

- **Color measurement**

  Surface color of spreadable tofu with some additives samples were determined according to the tristimulus color system described by Francis (2000) using spectrophotometer (MOM, 100D, and Hungary). **Color** coordinates X, Y&Z were converted to corresponding hunter L*, a*& b*, from where

  $$\text{Hue (hc = arc tan b/a)}, \text{ chroma } \left[ \text{C}^* = \sqrt{a^2 + b^2} \right], \text{ intensity } = \sqrt{(a^2 + b^2 + L^2)}$$

  Color coordinates according to formula given by manufacturer.

  - L: value represents darkness from black (0) to white (10))
  - A: value represents color ranging from red (+) to green (-)
  - B: value represents yellow (+) to blue (-)
  - C: Chroma
  - Hue (hc): tone angle or color
  - Intensity: chromaticity of color saturation

  The determinations were performed in triplicate, with the calibrated equipment, using 3 samples from each formulation indicated by Pathare, et al. (2012).

**Rheological properties**

- **Texture profile analysis (TPA)**

  Texture profile analysis test of samples was done using a Universal Testing Machine (TMS-Pro) Food Technology Corporation, Sterling, Virginia, USA) equipped with 1000 N (250 lbf) load cell and connected to a
The material for the present study, the experiment was conducted:

RESULTS AND DISCUSSION

- The preliminary Experiment

Soybean product

In order to select, a product from soybean products as a base material for the present study, the experiment was conducted:

Suitable emulsifying salts and stabilizers

Different types of emulsifiers and emulsifiers were tested:

Q₃ (3%) and special S₉ (2.5%) were selected as emulsifying salts as the product had a good texture similar to cheese made from the natural milk.

Appropriate flavors

a. Artificial flavorings materials: Three materials were tested for flavor, i.e. Cheddar cheese, black peppers and green olives. Good results have given a high degree of sophistication in sensory judgment.

b. Natural nectars: Natural nectars of fruits, vegetables and spices were used.

Fruits (orange pulp - peach - guava - mango - strawberry - black berries - pomegranate- red plum) with different proportions.

Vegetables (chopped green peppers, chopped pickled green olives, chopped black olives, dried tomatoes and ground dried carrots with different proportions.
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Spices: different ratios of Black pepper with green peppers.

Based on the sensory judging, 15% peach pulp and 20% guava pulp were selected.

5 % chopped green olives and a mixture of 0.2% ground black pepper with 2.5% chopped green peppers was selected.

Fat kind

Different materials were tested: cocoa substitute butter - coconut oil - olive oil – Palm oil and shortening). Palm oil gave an excellent product that did not affect the flavor of the final product.

- Instrumental analysis of color.

From data in table (1), it could be seen that L value (which the whiteness of sample) was decreased with adding fruit, vegetable and spices to tofu. It took 80.16, 79.37, 76.12, 79.28, 75.70 and 75.40 for control, T1, T2, T3, T4 and T5 in respective order. The same trend was observed of A value (which reflect the blue and red color) and B value (which reflect the yellowish color).

It could be concluded that whiteness of sample was increased while yellowish was decrease because of tofu, this results agree with Agrahar (2014) who found that L values from 78.8 to 87 and B values from 13.4 to 18.8, and would easily gain acceptance in populations who consumed these products.

Table (1): Color characteristics of spreadable tofu products in fresh

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values in spreadable tofu blends</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>T1</td>
</tr>
<tr>
<td>L</td>
<td>80.16</td>
</tr>
<tr>
<td>A</td>
<td>-6.4</td>
</tr>
<tr>
<td>B</td>
<td>17.44</td>
</tr>
<tr>
<td>H*</td>
<td>69.8</td>
</tr>
<tr>
<td>C*</td>
<td>18.58</td>
</tr>
<tr>
<td>Intensity</td>
<td>82.29</td>
</tr>
</tbody>
</table>

C: spreadable tofu without any flavor, T1: spreadable tofu with Chopped green olives, T2: spreadable tofu with Mix ground black pepper
and chopped green peppers. T3: spreadable tofu with sugar; T4: spreadable tofu with guava pulp, T5: spreadable tofu with peach pulp, C*: Chroma, H*: Hue (hc), tone angle or color

Similar observation was noticed by Jayasena, et al. (2010) reported that A white, creamy white or light yellow color would be considered as a desirable tofu characteristic that ascribed to ingredients kinds in control and treatments.

- **Texture profile analysis**

Table (2) illustrated texture properties of spreadable tofu blend. Data indicated as hardness ranged (1.2-8.4N), cohesiveness (0.19-0.63), springiness (2.48-8.00mm), gumminess (0.6-2.6N) and chewiness (3.69-12.66 m.j). The highest hardness values was treatment T4 which contain tofu with 20% guava pulp compared to control and other treatments.

**Table 2.** Textural profile analysis (TPA) of spreadable tofu products.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Storage period (month)</th>
<th>Ratio of tofu%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Hardness (N)</td>
<td>Fresh</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Cohesiveness(Ratio)</td>
<td>Fresh</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.54</td>
</tr>
<tr>
<td>Springiness (mm)</td>
<td>Fresh</td>
<td>2.48</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4.53</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.97</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7.97</td>
</tr>
<tr>
<td>Gumminess (N)</td>
<td>Fresh</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.38</td>
</tr>
<tr>
<td>Chewiness (m.j)</td>
<td>Fresh</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>10.89</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6.54</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4.17</td>
</tr>
</tbody>
</table>
C: spreadable tofu without any flavor, T1: spreadable tofu with Chopped green olives, T2: spreadable tofu with Mix ground black pepper and chopped green peppers, T3: spreadable tofu with sugar; T4: spreadable tofu with guava pulp, T5: spreadable tofu with peach pulp.

Cohesiveness, gumminess and chewiness was positively related to the hardness of treatments compared to springiness took the opposite line with the hardness. These findings agree with those of Gholamhosseinpour et al. (2018).

- **Meltability**

Obtained data in Table (3) showed that meltability value in control, T1, T2, T3, T4 and T5 ranged (49-72), (33-55), (42-53), (35-71), (32-70) and (31-70), respectively. Nevertheless, the control showed the highest value compared to other treatments.

**Table 3.** Change in meltability (mm) of spreadable tofu products.

<table>
<thead>
<tr>
<th>Storage period (month)</th>
<th>C</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>72</td>
<td>55</td>
<td>53</td>
<td>71</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>1</td>
<td>68.8</td>
<td>44.1</td>
<td>52</td>
<td>66</td>
<td>54</td>
<td>50.5</td>
</tr>
<tr>
<td>2</td>
<td>56.1</td>
<td>46</td>
<td>47</td>
<td>53.5</td>
<td>51</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
<td>33</td>
<td>41</td>
<td>35</td>
<td>32</td>
<td>31</td>
</tr>
</tbody>
</table>

C: spreadable tofu without any flavor, T1: spreadable tofu with Chopped green olives, T2: spreadable tofu with Mix ground black pepper and chopped green peppers, T3: spreadable tofu with sugar; T4: spreadable tofu with guava pulp, T5: spreadable tofu with peach pulp.

These results in harmony with Farahmandfar et al (2010, 2011) proved that the decrease in stretch ability could be due to less percentage of casein available for conversion to mono-calcium-paracaseinate by the addition of soy solids, also the spreads became less rubbery, lack elasticity, impaired flow and stretchability with increasing substitution of plant protein e. g., soy protein.
REFRANCES

Some physicochemical and rheological properties of prepared spreadable tofu blends


Some physicochemical and rheological properties of prepared spreadable tofu blends.

- **Something about tofu blends.**

  - Some physicochemical and rheological properties of spreadable tofu blends.
  - Sample properties include:
    - **pH:** 7.6 - 7.8
    - **Drying Time:** 34 - 70 minutes
    - **Viscosity:** 8.2 - 70 (31 - 70) (31 - 70) (31 - 70) mm^3
    - **Texture:** Hard (6.2 - 8.0 N)
    - **Color:** Brown (24 - 26.6 mm)
  
  - Other properties include:
    - **Water Content:** 8.4% ± 0.6%
    - **Protein Content:** 6.9 - 72%
    - **Fat Content:** 19 - 63%

  - The properties of the blends are influenced by:
    - **Ingredients:** Soybeans, water, and fillers.
    - **Processing Methods:** Blending, homogenization, and drying.

  - The blends are suitable for:
    - **Spreadability:** Easy to spread and apply.
    - **Nutritional Value:** High in protein and low in fat.

  - The blends can be used in:
    - **Food Products:** Snacks, spreads, and spreads.
    - **Medical Applications:** Oral care products.

  - Further studies are needed to:
    - **Optimize Formulations:** Adjusting ingredients and processing methods.
    - **Expand Applications:** Exploring new uses and markets.

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*Note: The provided text is a translation and may not fully capture the original content.*