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Study on physicochemical and sensory characteristics of peanut yoghurt

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Abstract

This present investigation aimed to study the influence of incubation temperature and skimmed milk ratio on the physicochemical properties, microbiological and sensory characteristics of peanut yoghurt. The methods of the Association of Official Analytical Chemistry International (AOAC) and the Indonesian National Standard (SNI) were used to analyse the physicochemical properties of peanut yoghurt. Analysis of one variance (ANOVA) was performed to evaluate the difference between the data via SPSS Version 17 and Microsoft Excel 2016. Yoghurt was made by using different incubation temperatures (37 and 45°C), incubation times (18 and 24 hrs) and skimmed milk ratios (3 and 5%). The results showed no significant differences (P>0.05) between the physicochemical of peanut yoghurt samples in colour, culture cells and total solids, whilst there were significant differences (P≤0.05) between each peanut yoghurt sample in pH (3.89, 41.17, 33.76, 4.29, 3.88, 3.86, 3.62, and 4.20) and viscosity (5.40, 5.40, 5.50, 5.10, 4.80, 4.10, 4.90, and 4.50). General results from this present study established that producing yoghurt from peanut milk by incubation temperature at 37°C for 18 hrs and skimmed milk ratio of 3%, increased the physicochemical and sensory properties of peanut yoghurt based on reducing the aroma of peanut.

1. Introduction

Peanuts (*Arachis hypogea*) are globally known and are consumed in various forms of processed food, but most are traditionally processed. Peanuts are a high source of protein and oil, they contain many functional compounds such as fibres, polyphenols, anticorrosion, vitamins and minerals. Some recent studies report that peanuts are a source of important compounds such as resveratrol, phenolic acids, flavonoids and phytosterols which inhibit the absorption of cholesterol from food. It is also a source of Co-enzyme Q10 and contains all twenty amino acids with the highest amount of arginine. Protein, fat, and fibre are the main components that make up peanuts. It is a commodity with a protein content that is superior in quantity and quality compared to other peanuts, allowing it to be processed into nutritionally rich dairy products (Elsamani, 2014)

The scarcity of milk supply in developing countries has led to the development of alternative milk sources from vegetable sources as vegetable milk could be used as vegetarian nutrition or for medical reasons, in cases of milk allergies and galactosemia (Onweluzo and Nwakalor 2009). Peanut milk is a non-dairy beverage created using peanuts and water. Recipe variations include salt, sweeteners, and grains. It does not contain any lactose and is therefore suitable for people with lactose intolerance. Similar in production to almond milk, soy milk, and rice milk, the peanuts are typically ground, soaked, sometimes heated, and then filtered through a fine filter, the resulting liquid is considered the milk. Peanut milk is of significant interest to nutritionists as a possible substitute for cow and human milk. In this regard, peanuts milk has been used in combination with cowpea for the preparation of vegetable milk chocolates (Aidoo *et al*., 2010), or with soybean and cow milk for the preparation of yoghurt (Kpodo *et al*., 2014). Probiotics are defined as live microorganisms when

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administered in adequate amounts, confer a health benefit on the host (Hill *et al*., 2014).

Lactic acid bacteria (LAB) is a large group of bacteria widespread in nature and beneficial in our digestive systems. They are the most important microorganisms used in food fermentation, contributing to the taste and textures that inhibit food spoilage (Magdoub *et al*., 2015). The benefits of LAB are represented in lactose digestion, intestinal microflora modulation, cholesterol reduction, cancer prevention and immune system stimulation (Desobry *et al*., 1999). Fermentation foods are considered as first foods produce and consumed since human civilization's development. Most fermented foods are made through the growth of microbes (Campanella *et al*., 2017). Milk type affects the acidity, the number of lactic acid bacteria and cohesiveness (Fadela *et al*., 2009).

LAB can produce antimicrobial compounds and it has contributed to human life (Khalisanni, 2011). LAB has been capable of degrading ochratoxin A during digestion gastrointestinal and *in vitro* which can be used in the silage industry, winemaking, and culture during alcoholic fermentation (Luz *et al*., 2018). It can help digest food in the intestine and ferment a variety of foods and turn them into tasty food products with increased shelf life (Teusink and Molenaar, 2017). LAB is capable of degrading peptides with antioxidant activity through proteolysis (Rizzello *et al*., 2017).

Yoghurt is one of the most common dairy products worldwide. Its production includes several steps (Medeiros *et al*., 2015; Ibrahim *et al*., 2019). Yoghurt is rich in nutrients as well as minerals, vitamins, and protein. Therefore, considered suitable for children and adults (Agustini *et al*., 2017). Cow milk yoghurt is widely consumed throughout the world. Moreover, there is a high demand for alternatives to cow milk due to problems associated with allergenicity and gastrointestinal disorders (Chen *et al*., 2016). The quality of yoghurt depends on three factors; the quality of raw milk, process conditions and starter culture (Paskov *et al*., 2010; Ibrahim *et al*., 2020). On the other hand, reports are mentioning that goat milk has a higher digestibility rate and lower allergenic potential compared to cow milk. Moreover, the combination of cow and goat milk to produce yoghurt improves some milk compounds' content as lactose.

The yoghurt quality is affected by varied factors such as heat processing, incubation temperature, amount of culture inoculated and time of incubation (Lee and Lucey, 2010). The shelf life of yoghurt is two weeks. It can be safe for 14 days during storage at 5°C (Supavititpatana *et al*., 2010). This study aimed to determine the effect of incubation time and temperature on the physical, chemical, and sensory properties of peanut yoghurt.

2. Materials and methods

2.1 Collection samples

Samples of peanuts were collected from Nganjuk City- East Java-Indonesia. The skimmed milk powder was purchased from Aroma supermarket Purwokerto - Indonesia. The cultures of *Streptococcus thermophilus*, *Lactobacillus acidophilus,* and *Lactobacillus bulgaricus* (mixed 1:1:1) were obtained from the Faculty of Animal Science, Universitas Jenderal Soedirman - Purwokerto - Indonesia.

2.2 Manufacturing peanut yoghurt

Yoghurt was made from peanut milk that is the peanut milk pasteurized at 80°C for 5 mins, then was mixed with skimmed milk at a level ratio (3, 5%), then, inoculated with a 5% culture and incubated at 45, 37°C for 18 and 24 hrs. After analyses, viscosity, pH, total solids, total lactic acid bacteria (CFU/mL) and sensory evaluation was done.

2.3 Total solid

The Brix readings were calculated using an Abbe refract meter (PZO-RL1, Warsaw, Poland). As the refractive index of a sugar-containing solution is also temperature-dependent, refract meter is typically calibrated at 20°C. The equipment was calibrated with deionized water (refraction index = 1.3330, °Brix at 20°C) and the readings of the samples were performed (Brix or g/100 mL) according to Almeida *et al*. (2010).

2.4 pH determination

According to the method that was recommended by AOAC (2005), the pH value of yoghurt was determined by using a digital pH meter. Prior to use, the pH meter was standardized with a standard buffer solution of pH 4, pH 10, and pH 7.

2.5 Viscosity determination

Viscosity was measured using a viscometer digital and was expressed as a percentage according to the procedure recommended by AOAC (2005) method.

2.6 Total lactic acid bacteria

The bacterial activity analysis of the samples was carried out according to Igbabul *et al.* (2014) as described by Ehirim and Onyeneke (2013). Each sample was serially diluted in sterile, distilled water to obtain the inoculums. The aliquot of each dilution was cultured on

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2.7 Sensory evaluation

The sensory assessment tests were carried out in triplicate according to the hedonic scale 7-point. Around twenty panellists from Food Science and Technology students assessed the samples and acceptability in terms of aroma, colour, texture, taste, and overall acceptability. According to Arioui *et al*. (2016) and Ibrahim *et al*. (2020), this was carried out.

2.8 Statistical analysis

The descriptive explanatory method was employed to discuss the results. The analysis of variance (ANOVA) was performed to evaluate the difference between data by using SPSS for Windows (version 17) and Microsoft Excel (2016). The means were separated by Duncan's multiple range test. Significant differences were determined at P≥0.05 and P≥0.01 (Mohammad and El-Zubeir, 2011).

3. Results and discussion

3.1 Effect of incubation temperature, time and skimmed milk ratio on physicochemical properties of peanut yoghurt

Table 1 shows the effect of incubation temperature and time with skimmed milk ratio on peanut yoghurt quality. The result showed the pH of peanut yoghurt had significant differences (P≤0.05) in incubation temperatures (37-45°C) and the addition of skimmed milk (3 and 5%) and time of incubation period (18 and 24 hrs). The pH results of peanut yoghurt ranged between 3.62-4.29. The difference in pH values may be due to the effect of high temperature with time during incubation, the result is in agreement with a study by Ibrahim *et al*. (2019) who recommended that the high incubation temperature had a significant effect on decreasing the pH value of yoghurt.

The total solids value results of peanut yoghurt showed in Table 1. It ranged between 4.10-5.50%. From these results, the highest and lowest total solids were found in the T3 sample (37°C/24 hrs/skimmed milk 3%) and T6 sample (45°C/24 hrs/skimmed milk 3%) respectively. There were no significant differences among the total solid of each yoghurt sample that was treated by different incubation temperatures, incubation times and different skimmed milk ratios.

Table 1 exposes the results of the viscosity values of peanut yoghurt, that was ranged between 58.92-94.82. These results showed that the incubation temperature of 45°C had a significant effect on decreasing the viscosity of peanut yoghurt, and vice versa. The result showed that there were significant differences between all yoghurt samples in viscosity values. These differences may due to the effect of high incubation temperatures on the culture growth, which affect the yoghurt gel-producing capability. The longer fermentation time would produce thicker yoghurt viscosity. The declining moisture content was in line with the increase of total solids caused by LAB cell proliferation. Krisnaningih *et al*. (2019), Hamodah *et al*. (2018) and Ibrahim *et al*. (2020) reported that the increase in viscosity after pasteurization may be due to the effect of temperature on evaporating water from milk, consequently, leading to an increase in the percentage of some compounds, also associated with fat and protein contents in milk. The effects of pasteurization led to the breaking of the clumps or clusters of fat in raw milk and, consequently, increased fat content in milk, which is associated with increased viscosity, this indicates the direct relationship between protein and fat content to viscosity.

The colour value results of peanut yoghurt are shown in Table 1. These results showed there were no significant differences between all yoghurt samples that were treated by different temperatures (37 and 45°C), time (18 and 24 hrs) and skimmed milk ratio (3 and 5%) ranging between lightning, L* to greenness, a* (-) and

Table 1. Effect of incubation temperature, time and skimmed milk ratio on physicochemical properties of peanut yogurt

Treatment	PH	TSS	Viscosity	Colour a	Colour b	Colour L
T1	3.89±0.11[b]	5.40±0.22[a]	94.82±9.91[e]	-16.37±0.12[a]	23.47±2.45[a]	16.61±0.68[a]
T2	4.17±0.17[c]	5.40±0.22[a]	64.82±32.5[a]	-15.77±0.40[a]	22.17±3.95[a]	17.42±1.13[a]
T3	3.76±0.05[ab]	5.50±0.00[a]	88.72±6.66[cde]	-16.00±2.57[a]	25.43±2.48[a]	15.81±0.67[a]
T4	4.29±0.03[c]	5.10±0.22[a]	70.48±8.88[ab]	-15.33±1.53[a]	20.40±3.80[a]	13.91±3.65[a]
T5	3.88±0.04[b]	4.80±0.27[a]	58.92±11.68[a]	-14.77±14.77[a]	23.70±0.66[a]	17.38±3.92[a]
T6	3.86±0.21[b]	4.10±0.22[a]	75.20±3.93[bcd]	-14.40±14.40[a]	20.97±0.93[a]	20.23±0.21[a]
T7	3.62±0.21[a]	4.90±0.22[a]	92.08±6.55[cd]	-14.80±14.80[a]	22.87±0.75[a]	18.78±9.38[a]
T8	4.20±0.04[c]	4.50±0.00[a]	60.56±2.14[a]	-14.83±14.83[a]	27.73±4.01[a]	23.08±1.00[a]

T1 = 37°C/24 hrs/skimmed milk 5%, T2 = 37°C/24hrs/skimmed milk 3%, T3 = 37°C/18hrs/skimmed milk 5%, T4 = 37°C/18hrs/skimmed milk 3%, T5 = 45°C/24hrs/skimmed milk 5%, T6 = 45°C/24hrs/skimmed milk 3%, T7 = 45°C/18hrs/skimmed milk 5%, T8 = 45°C/18hrs/skimmed milk 3%.

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yellowish, b* (+). This result agrees with Ibrahim *et al*. (2019) who noted that the yoghurt colour ranges from white to yellowish-white.

The Latic Acid Bacteria cells are shown in Table 2. The culture cells of peanut yoghurt were 10.00, 14.33, 6.00, 6.00, 13.67, 25,33, 18,67 and 26,67 for samples T1, T2, T3, T4, T5, T6 respectively. These results showed that there were no significant differences between all samples in the number of lactic acid bacteria cells.

Table 2. Effect of incubation temperature and time with skimmed milk ratio on peanut yogurt

Treatment	LAB
T1	10.00±1.00[a]
T2	14.33±0.58[a]
T3	6.00±1.00[a]
T4	6.00±1.00[a]
T5	13.67±1.15[a]
T6	25.33±11.72[a]
T7	18.67±0.58[a]
T8	26.67±0.58[a]

T1 = 37°C/24 hrs/skimmed milk 5%, T2 = 37°C/24hrs/skimmed milk 3%, T3 = 37°C/18hrs/skimmed milk 5%, T4 = 37°C/18hrs/skimmed milk 3%, T5 = 45°C/24hrs/skimmed milk 5%, T6 = 45°C/24hrs/skimmed milk 3%, T7 = 45°C/18hrs/skimmed milk 5%, T8 = 45°C/18hrs/skimmed milk 3%.

3.2 Sensory evaluation of peanut yoghurt

The sensory evaluation of peanut yoghurt is shown in Table 3. The colour of yoghurt samples were ranging between 3.27-3.82. These results showed that the colour of the samples ranged from white to yellowish-white. There were no significant differences (P>0.05) between all samples in colour and flavour. The texture of all samples was 3.64 to 4.64. There was a significant difference (P≤0.05) between T1 and T6 samples and no significant differences between the other samples. The average value of the T6 sample is the lowest percentage compared to other samples, and the T1 sample value is the highest percentage compared with all samples. The aroma of peanuts in yoghurt samples showed a significant difference (P≤0.05) between T6 and T1 samples and no significant differences between other samples. The taste of yoghurt samples showed a significant difference (P≤0.05) between T1 and T6 samples, while no significant differences between other groups. The taste of yoghurt samples ranged from acidic to very acidic. The overall acceptability scores show that sample T5 has the highest percentage compared with other samples. These results showed there were no significant differences (P>0.05) between all peanut yoghurt samples. Therefore, the highest preference level was given to peanut yoghurt produced by the addition of 3% skimmed milk, and 5% starter culture and incubated for 18 hrs at 37°C. Ibrahim *et al*. (2019) revealed that the higher concentration of culture with increased incubation temperature for a long time increased the smell of fermented milk. Also, the reduction of pH value enhanced the sour and unique flavour of fermented milk products.

4. Conclusion

Considering the increasing complexity of the needs of different typologies of consumers, including vegetarians and subjects with intolerance/allergy to dairy products, this approach was applied in this work to obtain yoghurt-like beverages from peanut milk, using commercial yoghurt. The result indicated that yoghurt can be produced from peanut milk. These results showed no significant differences (P>0.05) between the physical and chemical properties of peanut yoghurt samples in colour, culture cells and total solids. There were significant differences (P≤0.05) between each peanut yoghurt sample in pH and viscosity. General results from this present study established that producing yoghurt from peanut milk by incubation temperature at 37°C for 18 hrs and skimmed milk ratio of 3% is capable of increasing the

Table 3. Sensory evaluation of peanut yogurt

Treatment	Colour	Taste	Peanut Aroma	Texture	Flavour	Overall acceptability
T1	3.82±0.39[a]	1.91±0.67[a]	3.36±0.64[bc]	4.64±0.64[d]	2.09±0.79[a]	2.09±0.90[a]
T2	3.55±0.50[a]	2.91±0.79[bc]	2.82±0.83[abc]	4.36±0.98[abc]	2.64±1.07[a]	2.55±1.08[a]
T3	3.64±0.48[a]	2.45±0.89[ab]	3.36±0.77[bc]	4.45±0.78[abc]	2.45±0.78[a]	2.45±0.78[a]
T4	3.82±0.62[a]	3.09±0.79[bc]	4.18±0.39[d]	4.47±0.96[abc]	3.27±0.75[a]	3.82±0.94[a]
T5	3.82±0.57[a]	2.64±0.88[abc]	3.55±0.89[cd]	4.55±0.78[cd]	2.91±1.00[a]	3.09±0.67[a]
T6	3.82±0.39[a]	3.45±1.16[c]	2.64±1.07[ab]	3.64±0.64[a]	2.73±0.75[a]	2.64±0.64[a]
T7	3.27±0.75[a]	2.45±0.89[ab]	3.36±0.88[bc]	3.82±0.83[abc]	2.64±0.64[a]	2.64±0.77[a]
T8	3.55±0.89[a]	3.09±1.24[bc]	2.55±0.66[a]	3.73±1.05[ab]	2.73±0.96[a]	2.91±1.00[a]

T1 = 37°C/24 hrs/skimmed milk 5%, T2 = 37°C/24hrs/skimmed milk 3%, T3 = 37°C/18hrs/skimmed milk 5%, T4 = 37°C/18hrs/skimmed milk 3%, T5 = 45°C/24hrs/skimmed milk 5%, T6 = 45°C/24hrs/skimmed milk 3%, T7 = 45°C/18hrs/skimmed milk 5%, T8 = 45°C/18hrs/skimmed milk 3%.

physicochemical and sensory properties of peanut yoghurt based on reducing the aroma of peanuts.

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