

Research Article

Nutritional and rheological properties of pumpkin seed based fruits spread

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Article Info

<https://doi.org/10.31018/jans.v14iSI.3602>

Received: March 10, 2022

Revised: May 9, 2022

Accepted: June 8, 2022

How to Cite

Rohini, C. *et al.* (2022). Nutritional and rheological properties of pumpkin seed based fruits spread. *Journal of Applied and Natural Science*, 14 (SI), 155 - 160. <https://doi.org/10.31018/jans.v14iSI.3602>

Abstract

Fruit spread is prepared by combining sugar with processed fruit juice, concentrated fruit juice, or whole fruit. Pumpkin (*Curcubita maxima*) seeds are commonly seen as industrial waste and discarded. Pumpkin seed was roasted and made into powder form. β -carotene rich fruits such as mango, papaya, and muskmelon were used to extract the pulp. To obtain a desired consistency of fruit spread, the fruit pulp (25%) was blended with roasted seed powder (70%) Fruits were scattered at 5° to 10° Brix and sugar was added. To extend the shelf life and improve the quality of the spreads, they were pasteurised at 60°C for 30 minutes. The spreads were packaged in two different types of packaging material food grade glass containers and polypropylene containers. They were kept in refrigerated conditions at 4°C for further analysis. After organoleptic evaluation, the fruits spreads were analysed for nutritional content, textural properties and microbial content. Pumpkin seed based fruit spreads have 15.23 to 15.64% moisture, 6.7 to 7.18 % protein, 4.53 to 4.89% fat, 5.29 to 5.69% fiber and 15.36 to 28.67% carbohydrates. The pumpkin seed based fruit spreads had 15.41 to 23.04°Brix of total soluble solids. The fruit spreads had 85.82 to 764.54 g hardness, -88.54 to -205.45 g adhesiveness, 0.87 to 0.95 springiness, 0.48 to 0.74 cohesiveness, 64.78 to 344.06 gumminess and 61.53 to 311.64 chewiness. The pumpkin seed based fruits spread had viscosities of 2.21 to 3.58 centipoises. The mango based fruit spreads had the highest score values among the fruit spreads. The fruit spread encompassed enormous bioactive compounds when compared to other fruit spreads available on the market.

Keywords: Nutritional values, Pumpkin seeds, Spreads, Textural properties

INTRODUCTION

Fruit spreads are prepared by combining sugar with processed fruit juice, concentrated fruit juice, or whole fruit. Pumpkin (*Curcubita maxima*) belongs to the genus *Cucurbita* and the family is Cucurbitaceae. *Cucurbita pepo*, *Cucurbita maxima*, and *Cucurbita moschata* are the three types of pumpkins. Pumpkin had 3.52% to 4.27% of seed content. Pumpkin seeds are called as pepitas, and are covered by white husk. It is used as a snack in the form of hulled or semihulled at all grocery

stores and it is used in the food industry. It is rich in medicinal and nutritive value. These are the reason it is used in therapeutic foods. The seed is high in protein and possesses pharmacological properties such as anti-diabetic, anti-fungal, anti-bacterial, anti-inflammatory, and antioxidant properties (Nkosi *et al.*, 2006).

Pumpkin seeds are commonly seen as industrial waste and discarded. Seeds are used for domestic purposes in several locations, whether raw, boiled, or roasted. They may be useful in the food industry because they are high in protein, fibre, minerals like iron,

zinc, calcium, magnesium, manganese, copper, salt and polyunsaturated fatty acids (PUFAs), phytosterol, and vitamins. Mango is one of the most important tropical fruits and it gives pleasant taste, aroma and high nutritional value. It is a rich source of water, sugars, fiber, minerals, vitamins and antioxidants. It has the highest concentration of polyphenols, micronutrients found in plants that have distinct health effects. (Shahidi *et al.*, 1992). It provides more phytochemicals, which have anti-inflammatory properties in a variety of chronic pathological illnesses linked to inflammatory responses. (Dhananjaya and Shivalingaiah 2016), (Impellizzeri *et al.*, 2015).

The pumpkin contains more bioactive chemicals that have antidiabetic and anticancer properties. The Caricaceae family includes papaya. It is high in iron, calcium, vitamins A, B, and C, and has a high nutritive value. It contains antiinflammatory, hypoglycemic, antifertility, hepatoprotective, wound healing, antihypersensitive, and antitumor carotenoids such as carotene, lycopene, anthraquinones, and glycosides. The laxative action of ripe papaya fruit ensures regular bowel motions (Yogiraj *et al.*, 2014). It is a highly perishable fruit because it contains high moisture content of approximately 90%. Muskmelon is the family of Cucurbitaceae. It contains a rich source of phenolic phytochemicals and other essential nutrients.

MATERIALS AND METHODS

Formulation of fruits and nuts spread

Fruits such as mango, papaya and muskmelon were made into pulp. The seeds were dehulled and roasted for 30 minutes at 150°C to remove the hard coating and reduce the raw odour. The seeds were ground and powdered after roasting to be included in the pulp. The ground seeds were sieved to obtain uniform particle size. Then the seed powder was mixed and ground with fruit pulp to make a paste or thick consistency and the required amount of sugars was added to the paste. The standardization of fruit spreads was performed based on the organoleptic evaluation of seed powder (25) incorporating fruit pulp (70%) to obtain the desired consistency of fruit spread. To extend the shelf life of the product and minimize microbiological growth, the spreads were pasteurised at 60°C for 30 minutes. It was kept at refrigerated temperature (4°C) for further analysis. (Table 1)

Table 1. Combination of fruits spread

Treatment	Fruits (70%) + seed powder (25%)
T ₁	Mango + pumpkin seed powder
T ₂	Papaya + pumpkin seed powder
T ₃	Muskmelon + pumpkin seed powder

Physical properties

Moisture

The moisture content of food samples was determined by the hot air oven drying method. A 5g of food sample was taken in a petridish to determine the moisture content. Samples of empty petridish and petridish were weighed. The maintained oven temperature was up to 110°C. The petridish was placed in the oven, after 1 hour the petridish was weighed. The same procedure was repeated again 2 or 3 times to obtain the concordant value. The dried sample was cooled in a desiccator and further used for measurement of weight

$$\text{Moisture content\%} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Eq.1

Texture analysis

A texture analyser calibrated for a 10 kg load cell was used to determine textural qualities (hardness, firmness, cohesiveness, springiness, gumminess, chewiness, and resilience). At 40% compression, the property was measured with a probe with a diameter of P/2 mm and P/36 R mm. The maximum force obtained during compression was defined as texture.

Chemical properties

Protein

Protein was determined by the amount of nitrogen found in the sample by using the Micro Kjeldhal method. A 0.1 g sample was taken and added to a 250 ml digestion tube with 3g of catalyst mixture and 10 ml concentrated sulfuric acid. The catalyst mixture contains sodium or potassium sulfate and copper sulfate in the ratio of 5:1. The sample was digested at 400°C for 3 hours until the solution became colorless.

After digestion the sample was placed in the distillation unit to recover the ammonia content. The solution was distilled and ammonia was collected on the receiver side. After distillation the solution was titrated against 0.1N hydrochloric acid for the end point until the colour changed. The same procedure was repeated again to obtain a blank titre value and to calculate the nitrogen content in the sample by multiplying by a factor of 6.25, which provided the crude protein content of the sample in % (Ma and Zuazaga 1942).

Calculation

Nitrogen % = (Sample titre value – blank titre value) x Equivalent weight of alkali x Normality of HCl x 100 / weight of sample x 1000

Protein % = Nitrogen % x conversion factor (6.25) other foods

Eq.2

Fat

The fat content was determined by using a sox plus apparatus. The oil content in the sample was extracted

with petroleum ether (60-80°C) in Soxhlet apparatus for two hours. The solvent was evaporated in the hot air oven and after 1 hour the remaining residue was weighed. The fat content was expressed as %

Calculation

$$\text{Fat \%} = \frac{W_3 - W_2}{W_1} \times 100$$

Eq.3

W₁ – Sample weight

W₂ – Flask weight

W₃ – Flask with fat residue weight

Crude fiber

The crude fiber content was estimated in the fruit and nut spread. The fatted sample was taken in a pre-weighed glass crucible (W₁), and fixed in a crucible holder with a glass extractor. Then 150 ml of preheated 1.25% H₂SO₄ was added to the extractor and the sample was boiled at 500°C for 30 mins and 400°C for 30 mins. The acid solution was sucked from the extractor through a fibra flow system. The residue was washed with distilled water to remove the acidity in the sample. Then 150 ml of preheated 1.25% NaOH was added and digested at 500°C for 30 mins and followed by 400°C for 30 mins. Then the solution was drained out from the extractor and washed with distilled water to remove the alkalinity. The sample was dried at 100°C for one or two hours in the hot air oven, cooled and weighed.

Calculation

$$\text{Crude fiber \%} = \frac{W_3 - W_2}{W_1} \times 100$$

Eq.4

W₁ = Weight of sample

W₂ = Weight of crucible

W₃ = weight of residue with crucible

Carbohydrate

The total carbohydrate content of the food sample was measured. Carbohydrates are hydrolyzed into simple sugars using dilute hydrochloric acid. Glucose was dehydrated into hydroxymethyl furfural in a hot acidic medium. The addition of anthrone reagent resulted in a green-colored compound with a maximum absorption wavelength of 630 nm.

One hundred milligrams of sample was weighed and transported to a boiling tube, where it was hydrolyzed for three hours with the addition of 5 ml of 2.5 N HCL in a boiling water bath before being cooled to room temperature. Sodium carbonate was used to neutralize the solution. The mixture was then increased to 100 mL and centrifuged to separate the supernatant. From the centrifuge tube used as a test solution, 0.5 ml and 1.0 ml of supernatant solution were extracted. Glucose solution was prepared, used as a working standard and

taken into different concentrations such as 0.2, 0.4, 0.6, 0.8 and 1 ml. Then 4 ml of anthrone reagent was added to all the test tubes and heated for 8 mins. Cooled rapidly and readed at 630 nm. A standard was drawn by plotting different concentrations of the standard against absorbance and the amounts of carbohydrate in the food sample were calculated.

Calculation

Amount of carbohydrate present in 100 mg of the sample = mg of glucose/Volume of test sample x 100

Eq.5

Microbiological examination of the products

The microbial load of the stored sample was enumerated in the fruit and nut spread. The media used for bacteria: nutrient agar media for fungi: Martin's rose bengal agar and for yeast: yeast extract malt agar medium. The samples were diluted in order. For all of the tests, dilutions of 10⁻⁴, 10⁻⁴ and 10⁻⁶ were used. In sterile petridishes, one ml of serial dilutions of the samples was obtained and appropriate media for the specified organism was added. The colonies were counted after 48 hours of incubation at room temperature for bacteria, 3 days for yeast, and 5 days for fungi.

RESULTS AND DISCUSSION

The proximate composition of the pumpkin seeds (100) showed 4.07% moisture, 25.93% protein, 18.26% fat, 19.58% fiber, 27.23% carbohydrate and 2.84% ash. Devi *et al.*, (2018) determined that the pumpkin seed contained 30.23 g protein, 49.05 g fat, 6 g fiber and 10.71 g carbohydrate. Elinge *et al.*, (2012) analyzed the nutritional composition of pumpkin seeds and reported that they contained 5% moisture, 27.48 g of protein, 38 g of fat, 1 g of fiber and 28.03 g of carbohydrate.

Physical and chemical properties of fruits spreads

Table 2 shows that the mango and pumpkin seed spread contained 15.23% moisture, 7.18% protein, 4.89% fat, 5.59% fiber and 28.67% carbohydrate. Papaya and pumpkin seed spread contained 15.36% moisture, 7.01% protein, 4.53% fat, 5.69% fiber and 19.55% carbohydrate. Muskmelon and pumpkin seed spread contained 15.64% moisture, 6.78% protein, 4.65% fat, 5.29% fiber and 115.36% carbohydrate. Bekele *et al.*, (2020) reported that the moisture content of mango jams has been 22.01% to 29.87%. As the concentration of sugar and pectin increased, there was a slight decrease in the moisture content. This will help reduce microbial growth and increase the jam's shelf life.

Mishra and Pandey (2019) found that roasted pumpkin seed value added products were rich in protein

(20.12%). Pumpkin seeds could make a considerable contribution to the daily protein requirement for humans, which is estimated to be between 23 and 56%. Dhiman *et al.*, (2018) determined that cookies supplemented with pumpkin seed powder have 18.05% fat at 20% incorporation of pumpkin seed powder. Malakanthi *et al.*, (2018) determined that the fiber value of 5% pumpkin seed powder blended biscuits is 1.40 g. Kumari and Sindhu (2019) reported that 68.15 g of carbohydrate was present in cookies with 20% germinated pumpkin seed flour and 80% refined wheat flour.

Rheological properties of fruits spreads

Table 3 shows T₁ contained 85.99 g of hardness, -88.65 g.sec of adhesiveness, 0.95 percent of springiness, 0.73% of cohesiveness, 64.81% of gumminess, 61.69% of chewiness, 0.06% of resilience and 2.34 centipoises of viscosity in the fruit and nut spread. T₂ contained 709.05 g of hardness, -154.45 g.sec of adhesiveness, 0.87% of springiness, 48% of cohesiveness, 344.27% of gumminess, 311.84% of chewiness, 0.07% of resilience and 3.21 centipoise of viscosity in the fruit and nut spread. T₃ contained 155.47 g of hardness, -205.76 g.sec of adhesiveness, 0.91% of springiness, 0.68% of cohesiveness, 106.27 % of gumminess, 97.05% of chewiness, 0.06% or resilience and 3.61% of viscosity. Mazaheri-Tehrani *et al.*, (2009) reported that the adhesiveness of soy flour fortified with peanut spreads contains 6.116 to 267.6 adhesiveness. Replacing peanut spreads with soy flour significantly increased the adhesiveness (P<0.05).

Microbial load

Total plate count of pumpkin seed based fruits spread

Fruit spreads packed with two types of packing materials, polypropylene and glass containers, and maintained at a refrigerated temperature (4°C), had a microbial population spread out over storage periods. At 30-day intervals, a total plate count of fruit spread was performed. Because the fruit spread samples were freshly manufactured in a clean environment and held at refrigeration temperature at 4°C, there was no bacterial count at 0 and 30 days. At 60 days, the polypropylene packed container spread samples had 2×10³ to 4×10³ (Cfu/ml) total plate counts. At 90 days 5×10³ to 7×10³ (Cfu/ml) of the bacterial population was found in the fruit spread during storage. In a glass container, initially at 0, 30 and 60 days, no bacterial population in fruit spread was freshly prepared and stored at 4°C. At 90 days the minimum bacterial count obtained in the stored fruit spread ranged between 2 ×10³ and 5×10³. (Table 4)

Bhos *et al.*, (2019) evaluated that at regular intervals of two days, a total plate count of nutritious spread was performed. Because the nutritious spread sample was freshly prepared in a clean environment, there was a count of 4.0×10³ Cfu/ml at zero days. Up to 14 days, the total plate count of nutritious spread was within the permissible level, but on the 16th day, the total plate count was 10.54×10³, which was above the allowed limit. As a result, it is determined that nutritious spread has a 14-day shelf life. The total plate count of nutri-

Table 2. Proximate composition of fruit spread (100 g)

Parameters	T ₁	T ₂	T ₃
Moisture (%)	15.23	15.36	15.64
Protein (%)	7.18	7.01	6.7
Fat (%)	4.89	4.53	4.65
Fiber (%)	5.59	5.69	5.29
Carbohydrate (%)	28.67	19.55	15.36

(T₁ - Mango + pumpkin seed powder, T₂ - Papaya + pumpkin seed powder, T₃ - Muskmelon + pumpkin seed powder)

Table 3. Texture properties of pumpkin seed based fruit spread

Parameters	T ₁	T ₂	T ₃
Hardness (g)	85.99	709.05	155.47
Adhesiveness (g.sec)	-88.65	-154.45	-205.76
Springiness	0.95	0.87	0.91
Cohesiveness	0.73	0.48	0.68
Gumminess	64.81	344.27	106.27
Chewiness	61.69	311.84	97.05
Resilience	0.06	0.07	0.06
Viscosity (centipoises)	2.34	3.21	3.61

(T₁ - Mango + pumpkin seed powder, T₂ - Papaya + pumpkin seed powder, T₃ - Muskmelon + pumpkin seed powder)

Table 4. Changes in microbial content (Cfu/ml) in polypropylene pumpkin seed based fruit spread

Storage days	T ₁		T ₂		T ₃	
	TPC	Yeast & mold	TPC	Yeast & mold	TPC	Yeast & mold
0days	Nil	Nil	Nil	Nil	Nil	Nil
30 days	Nil	Nil	Nil	Nil	Nil	Nil
60 days	2×10 ³	2×10 ³	3×10 ³	3×10 ³	4×10 ³	4×10 ³
90 days	5×10 ³	3×10 ³	6×10 ³	4×10 ³	7×10 ³	5×10 ³

(T₁ - Mango + pumpkin seed powder, T₂ - Papaya + pumpkin seed powder, T₃ - Muskmelon + pumpkin seed powder)**Table 5.** Changes in microbial content (Cfu/ml) in glass container pumpkin seed-based fruit spread

Storage days	T ₁		T ₂		T ₃	
	TPC	Yeast & mold	TPC	Yeast & mold	TPC	Yeast & mold
0days	Nil	Nil	Nil	Nil	Nil	Nil
30 days	Nil	Nil	Nil	Nil	Nil	Nil
60 days	Nil	Nil	Nil	Nil	Nil	Nil
90 days	2×10 ³	1×10 ³	4×10 ³	2×10 ³	5×10 ³	3×10 ³

(T₁ - Mango + pumpkin seed powder, T₂ - Papaya + pumpkin seed powder, T₃ - Muskmelon + pumpkin seed powder)

tious spread was below the allowed limit for the first 14 days, but then exceeded it on the 16th day, leading to the conclusion that nutritious spread has a shelf life of 14 days at refrigerated temperature. If the total plate count (Cfu/ml) of fruits and vegetables exceeds ×10³ Cfu/ml, the product is reported as unsafe.

Yeast and mould counts were found in fruit spreads packed in various types of packing materials, such as polypropylene and glass containers, and stored at 4°C in the refrigerator. Initially, the yeast and mould counts were performed on a regular basis. In polypropylene container, initially at 0 and 30 days, there was no count in the fruit spread since it was freshly prepared in a clean environment and stored at 4°C. After 60 days, the yeast and mold count was obtained in the fruit spread from approximately 2×10³ to 4×10³ and at 90 days the count of yeast and mold was 3×10³ to 5×10³. Initially, 0, 30 and 60 days, there was no count in freshly prepared and stored fruit spread in a glass container. After 90 days, the stored fruit spread observed minimum yeast and mold count of approximately 1×10³ to 3×10³ was observed in the stored fruit spread (Table 5).

Bhos et al. (2019) reported that the count of yeast and mould in the nutritious spread was done at regular intervals of two days. There was no count at 0 days because the nutritious spread was freshly prepared in a clean setting. Yeast and mould counts in nutritious spread were below acceptable limits until the 14th day when they were discovered to be 4.98 × 10³, which was beyond the allowed level. Yeast and mould counts in the nutritious spread were within acceptable limits up to 14th days, but after 16th days, yeast and mould counts were higher than acceptable levels, leading to the conclusion that nutritious spread has a 14th day

shelf life at refrigerated temperatures. If the yeast and mould count (cfu/ml) of fruits and vegetables exceeded 4×10³/ml cfu/ml, the product would be considered spoilt.

Conclusion

Packaging the fruit spread in suitable packaging material and storage at refrigeration temperature could extend the shelf life of the product with minimum changes in the chemical composition. The storage stability of the fruit spread packed in glass containers was found to be good when compared to polypropylene containers. Pumpkin seeds are considered underutilized seeds, but they have enormous nutritional value and nutraceutical properties. Fruit spread was used in the spread to increase the nutraceutical value of the spread and it is highly preferred for all age groups and preferred as the best ready to use food. The fruit spread encompassed enormous bioactive compounds compared to other fruit spreads available on the market.

Conflict of interest

The authors declare that they have no conflict of interest.

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