



Sensory Attributes of Jackfruit: A beyond Meat Sandwich Filling

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Abstract

Jackfruit is used as a meat substitute by some consumers but reports on its use are scanty. Jackfruit is becoming popular among meat lovers who want non-soy-based meat alternative. Thus, this study aims to 1) discover a healthy and affordable option to meat and 2) assess if consumers can differentiate between pulled pork and jackfruit in a sandwich. Three types of sandwiches were prepared (i.e., jackfruit-in-water; pork tenderloin; jackfruit-in-brine). Sensory analysis using 300 untrained panelists was conducted to examine selected quality attributes (flavor, texture, aroma) and identify the meat-based sample. Panelists scored the sandwiches on a scale of 1-3 with 1 being most favored. The mean scores were calculated as follows: pork = 1.54, jackfruit in brine = 2.16, and Jackfruit in water = 2.18. Statistical analysis (2 tailed T-test) found a significant difference ($p = 0.003$) in flavor between the pork sandwich (score = 1.6) and those of jackfruit in brine (score = 2.17) and water (score = 2.17). There was a significant difference ($p = 0.05$) in the texture of pork sandwich (score = 1.6) and jackfruit sandwich in brine (score = 2.0) and water (score = 2.3). Most tasters thought the jackfruit was a meat product although the meat product was ultimately favored. Participants did not know that the sandwiches had a meat substitute. Jackfruit could be a desirable meat substitute for consumers who are looking for low-fat meat alternative rich in antioxidants to add to meals.

Introduction

Jackfruit provides health benefits such as phytochemical and antioxidant activity that is absent in meat products. Maintaining a healthy living is not a one-time activity but a wholesome lifestyle modification. Meat substitutes are part of the healthful trend in populations where meat is not always the best food people can consume. Jackfruit is a new and trendy fruit that allows consumers of meat to find an alternative to meat that is non-soy-based and can add essential nutrients to the diet. The question is, will jackfruit have similar or better aroma and texture to meat product.

A study on the effect of boiling on the functional and compositional properties of Mexican jackfruit showed no significant differences in the protein (13.52 g/100 g) and raw fiber (3.81 g/100 g) contents of raw and boiled Mexican jackfruit seed meals (Jurezbarrientos et al., 2017). However, the boiled sample displayed increased water absorption (3.34 g/g) and water solubility (14.65%) capacities. The data showed that raw dried jackfruit meal has good gelling properties while boiled jackfruit seed meal could be used to prepare ready-to-fry frozen precooked products (Jurezbarrientos et al., 2017).

The study on the effect of jackfruit supplementation (10%, 20% and 30% immature jackfruit) and ageing on the physicochemical, texture and sensory characteristics of Chevon patties found that jackfruit is a good meat alternative. The substituted meat had minor changes in physicochemical, microbiological, and sensory quality during refrigeration process (Verma et al., 2015). A report (Shafiq et al., 2017) on the phytochemical and nutritional properties of jackfruit show that it is a rich source of ascorbic acid, phenolics (239.87 mg GAE/100g dry weight) and flavonoids (109.94 mg QE/100g dry weight). Jackfruit is high in carbohydrates (13.08%) and fiber (6.32%) but lower in fat (5.63%) and protein (1.48%).

Jackfruit is as a functional food and nutraceutical resource. An in vitro antioxidant assay was used to determine the relevance of jackfruit to oxidative stress in human health (Maier & Basu, 2014). Data show that jackfruit extract has high diammonium salt (A734 = 35.6), nitric oxide (A542 81.7) and O- radical (A230 55.5) scavenging activities. Functional components of jackfruit as it relates to human health was reviewed. The rich bioactive profile of jackfruit makes it a highly nutritious and desirable food product (Swami et al., 2012). The percent composition of jackfruit shows 6.09% moisture, 1.27% crude fat, 2.70% ash, 13.50% protein, 3.19% fiber, 79.34% carbohydrate, 382.79 kcal energy/100 g, pH (5.78), and titratable acidity as lactic acid (1.12%), and bulk density 0.80 g/cm. The various physicochemical properties make jackfruit effective against diseases such as cardiovascular disease, development of certain cancers; and it promotes healthy mouth and skin (Swami et al., 2012). The objectives of this study were to i) examine if jackfruit is a suitable meat substitute, ii) develop a healthier and more affordable option to meat, and iii) assess if people can differentiate between jackfruit and pulled pork in a sandwich.

Study Hypotheses:

H1: The likeability (taste, texture, and aroma) of jackfruit, a meat substitute, will be similar or better than that of meat product (pulled pork).

H0: The likeability of jackfruit will be less than that of pulled pork

Methods

In this study, jackfruit and pulled pork (control) are the independent variables while flavor, texture, and aroma are the dependent variables. The sandwiches were prepared using regular method widely used by consumers (Food Network, 2020)

Pork tenderloin, young green jackfruit in water and young green jackfruit in brine were used to make barbeque sandwich fillings. Two tablespoons of filling were placed on a sliced Hawaiian roll sandwich (Organic Authority, 2018). A blind taste test was performed to determine preferences for the sandwiches without using appearance as a factor (McWilliams, 2017). A questionnaire to assess allergy and food preference was given to panelists before the sensory evaluation (McWilliams, 2017). A scorecard was used to document the preferences of 75 untrained panelists. The panelists were asked to rank their favorite sandwiches in flavor, texture, and aroma on a scale of 1-3, where 1= most favored and 3 = least favored (McWilliams, 2017).

Preparation of Sandwich Variations

Make barbecue sauce by adding 2 teaspoons olive oil into a saucepan and heat on medium low. Garlic was added and sautéed for 2 min, stirring frequently. Then add tomato puree, apple cider vinegar, and pertinent seasonings (e.g., maple syrup, molasses, paprika, onion powder, garlic powder, chili powder, cumin, pepper, and cayenne) into the saucepan. Whisk properly until a

well- mixed dispersion is achieved. Turn heat to high and bring to a boil. Reduce heat to medium-low and simmer for 30 min.

Place jackfruit on a cutting board. Cut out the core and remove any seeds. Then using your fingers or two forks, shred the jackfruit into a bowl. Drain and rinse jackfruit if using canned. Add barbecue sauce to the bowl of jackfruit and stir until jackfruit is completely coated. Then cover and place in the fridge to marinate for 1 hour.

Cut the pork tenderloin into 1-inch cubes and place in a bowl. Then add barbecue sauce to the bowl and let it marinate in the fridge for 1 hour. Heat a large skillet over medium-high heat. Add 1 tablespoon olive oil. Sauté jackfruit and pulled pork for 30 mins in separate pans. Remove from heat. Prepare jackfruit sandwiches by placing 2 tablespoons of each jackfruit mixture on a bun.

Repeat until all the mixture is used. Follow the same steps to prepare pulled pork sandwich. Table 1 shows the recipes of the original and modified (bolded font) sandwich filling.

Table 1. Recipe of Barbeque Jackfruit/Pulled Pork Sandwich Filling

Ingredients	
Original Recipe	Modified Recipe
<p><i>For the jackfruit/meat:</i> 2 ½ cups young jackfruit or pork tenderloin</p> <p><i>For the barbecue sauce:</i> 2 cups tomato puree ¼ cup apple cider vinegar ¼ cup pure maple syrup 2 tablespoons molasses 1 teaspoon sea salt 1 teaspoon paprika 1 teaspoon onion powder ½ teaspoon garlic powder ½ teaspoon chili powder ¼ teaspoon cumin ¼ teaspoon ground black pepper ⅛ teaspoon cayenne 2 minced garlic cloves 2 teaspoons olive oil Dash of liquid smoke</p>	<p><i>For the jackfruit/meat:</i> 2 ½ cups young jackfruit or pork tenderloin</p> <p><i>For the barbecue sauce:</i> 2 cups no salt added tomato puree 3 tablespoons apple cider vinegar ¼ cup pure maple syrup 2 tablespoons molasses</p> <p>1 teaspoon paprika 1 teaspoon onion powder, ½ teaspoon garlic powder ½ teaspoon chili powder ¼ teaspoon cumin ¼ teaspoon ground black pepper ⅛ teaspoon cayenne pepper 2 minced garlic cloves 2 teaspoons olive oil 4 drops of liquid smoke</p>

Sensory Evaluation: A blind taste test was performed to assess the panelists' preference of the sandwiches. An allergy and food preference questionnaire were given to untrained panelists before the sensory evaluation to provide full disclosure to participants who may have food allergy or preference. The panelists were asked to rank their favorite sandwiches in flavor, texture, and aroma, using a scale of 1-3 where 1 = most favored. A scorecard (Table 2) was used by panelists to rate the sandwiches. During the sensory evaluation, panelists were asked a follow-up question to obtain more insight about panelists' preference of the sandwiches. Panelists were asked a final question after they turned in their scorecard to prevent any swaying/bias from previous answers. The question was: Finally, identify the meat product(s).

Table 2 – Scorecard is provided to the panelists for rating the sandwich samples.

Please rate each sample (denoted with single-blind identification number) for each attribute using a scale of 1 to 3:

- 1 = most favorite
- 2 = middle favorite
- 3 = least favorite

Attribute	R175	P224	N192
Flavor			
Texture			
Aroma			

Moisture Composition and Nutritional Analysis

Moisture content of the sandwiches was measured by wettability test with slight modification (McWilliams, 2017; Weaver & Daniel, 2003). Wettability test was used to measure the percent weight increase. Exactly 5 g of each sample was placed in the oven at 90°C for 8 hrs. Then samples were taken out and placed in a desiccator to cool down. The samples were taken out and weighed until a constant weight was measured (i.e., similar final two measurements).

The nutrient profile of the samples was determined from Nutrition Databases (USDA Nutrient Database: <https://fdc.nal.usda.gov/ndb/>; Esha Research: <https://esha.com/nutrition-database/>). The nutrition fact labels (Fig. 3) was created via Online Labels.com

Result and Discussion

Moisture Content

The data show that pulled-pork sandwich lost 49% moisture while jackfruit-in-brine and jackfruit-in-water lost 61% and 63% moisture, respectively. This could directly impact the taste panel due to the loss in moisture. An explanation for this is that jackfruit provided and retained water in sandwiches better than pulled pork (Table 3).

Table 3. Moisture Composition of Sandwich Samples

Sandwich filling	Initial Weight (g)	Final Weight (g)	Mean Moisture Content (%)	Mean Moisture Loss/Absorption (%)
JF-in-brine	5.0	1.95	39	61
Pulled pork	5.0	2.55	51	49
JF-in-water	5.0	1.85	37	63

Visual Appearance of Jackfruit Sandwich Filling

Figure 1 show the images of the sandwich fillings and jackfruit (raw). A visual assessment show that the three sandwich fillings look similar in appearance. The panelists made similar observation during the taste panel. This supports the sensory scores of the sandwich fillings, an indication that the three filling samples were well liked by the panelists.

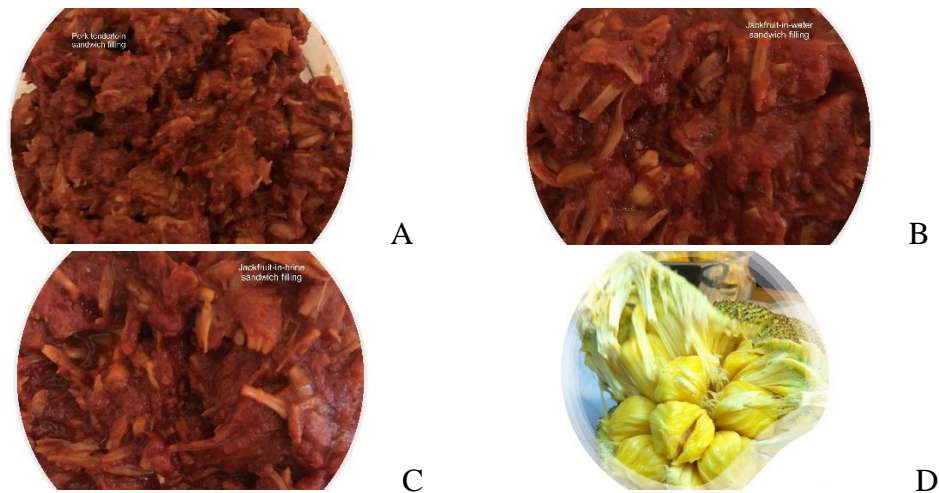


Figure 1. Images of the sandwich fillings and raw jackfruit. A: Pulled pork; B: Jackfruit-in-water; C: Jackfruit-in-brine; and D: Raw jackfruit

Overall Acceptability of Sandwiches

The likeability of the pulled-pork sandwich was compared to that of the other sandwiches made with jackfruit using ANOVA. The multivariate tests show that the ANOVA was not significant ($p=0.05$). This indicates that panelists liked the jackfruit sandwiches similarly as the pulled-pork sandwich. The mean score for likeability of the three sandwiches was calculated: pulled-pork (1.54), jackfruit-in-brine (2.16), and jackfruit-in-water (2.18). The panelists indicated there was more than one meat product despite having only one sandwich with meat product on the sample plate. Panelists could identify the pork sandwich but did not necessarily pick it as their favorite.

Sensory Characteristics of the Sandwiches

Figure 2 shows the mean scores of flavor, texture, and aroma of the three types of sandwiches. A T-test analysis shows significant difference ($p=0.007$) in flavor between pulled pork and the two jackfruit sandwiches. There was no difference in flavor between jackfruit-in-water and jackfruit-in-brine sandwiches. However, the flavor of either jackfruit sandwiches rated differently when compared to the flavor of the pulled-pork sandwich.

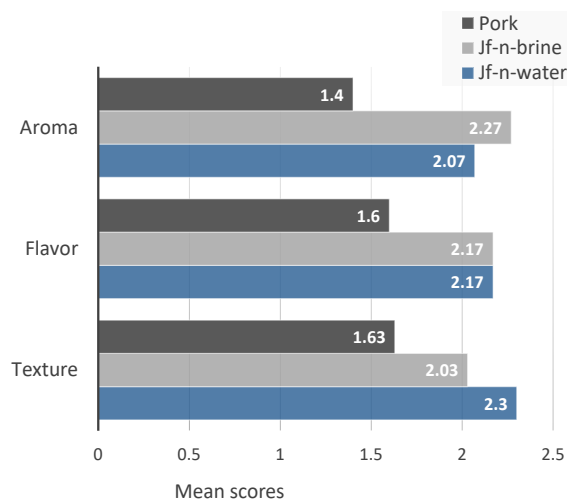


Figure 2. Mean sensory scores of the sandwiches (pulled pork, jackfruit-in-water, jackfruit-in-brine)

There was a significant difference ($p=0.05$) in the texture of the jackfruit-in-brine and the pulled-pork sandwiches. Similarly, the texture of the jackfruit-in-water sandwich and that of the pulled-pork sandwich was significantly different ($p=0.002$). There was a significant difference in aroma between pulled-pork and jackfruit-in-brine sandwiches ($p=0.00001$); and between pulled-pork and jackfruit-in-water sandwiches ($p=0.0008$). During sensory evaluation, the panelists did not know that the sandwiches were not all made with meat. The panelist could distinguish the pork sandwich but thought the other two sandwiches were made with a different type of meat. Notably the two jackfruit sandwiches were liked by the panelists – who stated that the jackfruit sandwiches tasted good but different. It is important to keep the sandwich filling warm and not let the jackfruit dry out. It was observed that as the jackfruit dries out, the product becomes a little saltier than a fresher product. This may skew panelists during the taste test. There are no published findings on the sensory properties of jackfruit in sandwich. Reports are mostly on the nutritional value of jackfruit in health and wellness. A nutritional analysis shows that pork is high in protein, fat, kcal, and salt (Swami et al., 2012).

Jackfruit has been shown to provide benefit for people with cardiovascular disease or those who need a reduced salt diet (Shafiq et al., 2017). However, consumers who may use jackfruit as a meat substitute will need to supplement their diet with a different high protein food due to the low protein content in jackfruit (Shafiq et al., 2017). An explanation for this is that jackfruit is not a meat replacement because it cannot match the nutrients in meat. However, it is a good meat substitute.

Another concept of using jackfruit is in a recipe with half jackfruit and half meat (50% jackfruit + 50% meat). Using jackfruit-meat at 50:50 ratio could be successful because the meat quality and texture of the product is retained while the nutrient quality is improved. One study showed that jackfruit can store well and retain its moisture under refrigeration but when the jackfruit is mixed with meat the moisture content is retained longer (Verma et al., 2015). The findings of this study show that the panelists liked the jackfruit sandwiches similarly as the pulled-pork sandwich.

Jackfruit filling may be different from meat but if prepared properly, it can compare well to meat and can be an adequate and desirable meat substitute.

Nutrient Composition / Nutrition Facts

Table 4 display an overview of the nutrient profile of pork tenderloin and jackfruit (raw). A comparison of the profile shows that jackfruit has vitamin A, C, and calcium which are absent in pork tenderloin. Furthermore, jackfruit has no cholesterol. This is evident since Jackfruit is a plant food compared to pork, an animal food.

This study provides insight that jackfruit could be a desirable meat substitute for consumers who are looking for antioxidant-rich, low-fat meat substitute to add to their diet. Jackfruit is a functional food that provides health benefits such as phytochemical and antioxidant activity that is not present in meat products. Based on its phytochemical properties, jackfruit may provide protection against health conditions such as cardiovascular disease and the development of certain cancers. Thus, jackfruit could be a recommended meat substitute for populations with cardiovascular disease and high blood pressure who love meat but are concerned about intake of foods high in calorie, fat, sodium, and cholesterol.

Table 4. The Nutrient facts/composition of pork tenderloin and jackfruit (raw).

Pork Tenderloin		Young Jackfruit, raw	
Serving Size	100 g	Serving Size	100 g
Amount Per Serving		Amount Per Serving	
Calories 106		Calories 95	
% Daily Value		% Daily Value	
Total Fat 2.1g	3 %	Total Fat 0.6g	1 %
Saturated Fat 0.7g	4 %	Saturated Fat 0.2g	1 %
Cholesterol 48mg	16 %	Cholesterol 0mg	0 %
Sodium 243mg	11 %	Sodium 2mg	0%
Total Carbohydrate 0g	0 %	Total Carbohydrate 23g	8 %
Dietary Fiber 0g	0 %	Dietary Fiber 1.5g	6 %
Sugar 0g		Sugar 19g	
Protein 20g	40 %	Protein 1.7g	3 %
Vitamin A 0 % • Vitamin C 0 %		Vitamin A 2 % • Vitamin C 23 %	
Calcium 0 % • Iron 5 %		Calcium 2 % • Iron 1 %	
Daily values are based on 2000 calorie diet.		Daily values are based on 2000 calorie diet.	

Conclusion

Jackfruit provides health benefits such as phytochemical and antioxidant activity that are not present in meat products. Its physicochemical properties provide protection against illnesses such as cardiovascular disease and the development of certain cancers. At the start of the sensory evaluation, the panelists were unaware that the sandwiches had meat substitute. Most panelists thought the jackfruit was a meat product although pulled-pork was ultimately favored. Although the pork was favored most in taste, texture, and aroma; many panelists liked the jackfruit sandwiches and agreed it could be a suitable meat substitute. Jackfruit could be a desirable meat substitute for consumers who are looking for a high antioxidant, low fat meat substitute to add to their diet. Meat substitutes are part of health trend where meat may not be the best food for an individual who cannot eat meat. Jackfruit is becoming popular among meat consumers – It allows them to find meatless options that are non-soy based and can add essential nutrients to the diet. Jackfruit could be recommended as a meat substitute for patients with cardiovascular disease and high blood pressure who want to watch their nutrient intake such as calorie, fat, sodium and cholesterol.

References

- Basu, P., & Maier, C. (2016). In vitro antioxidant activities and polyphenol contents of seven commercially available fruits. *Pharmacognosy research*, 8(4), 258.
- Calorie Counter (2017). Free Calorie Counter, Diet & Exercise Journal | MyFitnessPal.com.
- Juárez-Barrientos, J. M., Hernández-Santos, B., Herman-Lara, E., Martínez-Sánchez, C. E., Torruco-Uco, J. G., de Jesus Ramírez-Rivera, E., ... & Rodríguez-Miranda, J. (2017). Effects of boiling on the functional, thermal and compositional properties of the Mexican jackfruit (*Artocarpus heterophyllus*) seed Jackfruit seed meal properties. *Emirates Journal of Food and Agriculture*, 1-9.
- McWilliams, M. (1993). *Foods: experimental perspectives*. Macmillan.
- Organic Authority (2018). The Ultimate BBQ Jackfruit Pulled Pork Recipe. Organic Authority
- Shafiq, M., Mehmood, S., Yasmin, A., Khan, S. J., Khan, N. H., & Ali, S. (2017). Evaluation of phytochemical, nutritional and antioxidant activity of indigenously grown jackfruit (*Artocarpus heterophyllus* Lam). *Journal of Scientific Research*, 9(1), 135-143.
- Swami, S. B., Thakor, N. J., Haldankar, P. M., & Kalse, S. B. (2012). Jackfruit and its many functional components as related to human health: a review. *Comprehensive Reviews in Food Science and Food Safety*, 11(6), 565-576.
- Swami, S. B., Thakor, N. J., Haldankar, P. M., & Kalse, S. B. (2012). Jackfruit and its many functional components as related to human health: a review. *Comprehensive Reviews in Food Science and Food Safety*, 11(6), 565-576.
- Verma, A. K., Singh, V. P., & Pathak, V. (2015). Effect of jackfruit supplement and ageing on the Physico-chemical, texture and sensory characteristics of Chevon patties. *Journal of Applied Animal Research*, 43(3), 247-255.
- Weaver, C. M., & Daniel, J. R. (2003). *The food chemistry laboratory: a manual for experimental foods, dietetics, and food scientists*. CRC press.