

Wayamba University of Sri Lanka
Faculty of Agriculture and Plantation Management

19TH AGRICULTURAL RESEARCH SYMPOSIUM 2020

Guidelines for Authors

Introduction

The annual **Agricultural Research Symposium (AGRES)** of the Faculty of Agriculture and Plantation Management provides an opportunity for final year students to present, discuss and debate the outcomes of their research projects. Students are also benefitted by publishing their research as research articles in the proceedings of the symposium.

This document provides guidelines for the authors of 19th AGRES which will be held on 22nd January 2021.

General Instructions

- **Original papers:** Research data presented in the manuscript should be from undergraduate research projects carried out during year 2020. The authors should ensure that they have written original papers avoiding plagiarism. Permission must be obtained for use of copyrighted material from other sources (including the Internet).
- **Fundamental errors in the study:** Authors are requested to check for significant errors before submission. Authors are obliged for any fundamental errors found in the final paper.
- **Copyright:** Faculty of Agriculture and Plantation Management holds the copyright of published articles. Written permission of the faculty must be obtained for distribution outside the institution including sharing in websites.
- **Ethics:** Manuscripts that involve human or animal trials should obtain approval from any recognized Ethics Review Committee.
- **Submission of manuscripts:** Manuscripts should be submitted to the Publication Committee of 19th AGRES on or before the deadline set by AGRES Organizing Committee.
- **Review process:** The manuscripts will be reviewed by three internal reviewers. Revised manuscripts as per the reviewers' suggestions should be re-submitted before the set deadline. The accepted manuscripts should be presented orally at AGRES and they will be published in the proceedings of the symposium.

Specific Guidelines

Article structure

Title: Use a concise and informative title

Title should accurately indicate the subject and scope of the study using 10- 15 substantive words. Use of abbreviations should be avoided.

Running title: A short running title should be provided **in the header of odd-numbered pages**.

Author names and affiliations:

List all authors' names with initials before surname

e.g. A.B. PERERA, C.D. FERNADO and E.A. SILVA
UPPER CASE, Not bold.

Give full postal addresses of authors. Not bold. If more than one address, indicate each appropriate author by superscripts 1, 2, etc. next to his/her name.

Abstract: Stand-alone abstract limited to 200- 250 words.

Keywords: Provide 4 to 5 keywords in alphabetical order. First letter of words/phrases should be capital

Introduction: Give a concise background and justification for the study and state the objectives and hypotheses.

Methodology: Provide adequate detail on research methods to facilitate the work to be reproduced. Samples, analytical methods and statistical analysis should be explained in a concise manner. Mention the common analytical methods without much description by citing references.

Results and Discussion: Results should be clear and concise but complete. Discussion should compare the significance of the results of the study with published literature.

Conclusions: The conclusions of the study should be given concisely.

Acknowledgements: Briefly acknowledge the research grants (if any) and significant support you received for the research.

Language: Text should be written in Standard English (British). Manuscript should be 'spell checked' and 'grammar checked'.

Units: Use the international system of units (SI). A single space should be left between the numerical value and the unit or symbol. e.g. 25 ml, 20 °C, 50 kg

Acronyms and Abbreviations:

Acronyms and abbreviations should be written in full at the first time of appearance. Abbreviations can be used subsequently.

Scientific names: Italicize the whole name and capitalize only the first letter of genus name e.g. *Megalonyx jeffersonii*. After the first use, the genus name can be abbreviated to just its initial: *M. jeffersonii*.

Non-English terms:

All non-English terms should be *italicized*. e.g. *et al.*, *in vitro*, *in vivo*, *Yala*, *Maha*

Mathematical formulae: For simple fractions, use the solidus (/) instead of a horizontal line. For separate equations, use “equation editor”.

Levels of statistical significance can be indicated as: *P <0.05, **P <0.01 and ***P <0.001.

Tables:

“Insert” tables next to the relevant text in the article. Use **INSERT → TABLE** function in MS Word. Use only major horizontal rules and avoid vertical rules and shading in table cells. Number tables consecutively (Arabic numbers) in accordance with their appearance in the text. Table footnotes can be included below the table body for clarifications (Font size 9, *italic*).

Important: The tables should be inserted only *after* introducing the relevant text in the article.

Figures:

Include figures next to the relevant text in the article. Number these consecutively (Arabic numbers) in accordance with their appearance in the text and place figure captions below the figure. Insert a figure of uniform sizing to the original figure not a distorted one.

Figures should be of high resolution such as a minimum of 300 dpi and submitted as .tif or .bmp formats.

Composite figures should be labelled as (A), (B), (C), etc. and description should be provided in the figure caption (Font size 9, *italic*).

Abbreviations or symbols used in the figures should be written in full in the figure caption after giving the title (Font size 9, *italic*).

e.g.

Figure 4. Cross sections of different types of liposomes according to lamellar arrangement. (A) *Small unilamellar liposome*; (B) *Multilamellar liposome*; (C) *Multivesicular liposome*. *Hph- Hydrophilic head, Hpt- Hydrophobic tail, Lbl- Lipid bi-layer.*

Important: Figures should be inserted only *after* introducing the relevant text in the article.

Table titles and figure captions

Titles of tables are always placed at the top of the table. Captions of figures are always placed below the figure.

All Tables and Figures must have self-explanatory titles. The reader should be able to look at a table or figure and, simply by reading its title, know exactly what was done in that part of the experiment without having to read the text of the paper for information.

References:

Reference style

Reference style for AGRES publication has been adopted from the Harvard Referencing Style.

In-text citation

Include authors' **last name** and the year of publication.

- e.g. (Adams, 2009)- Single author
- (Smith and Jones, 2011)- Two authors
- (Smith *et al.*, 2012)- More than 2 authors- first author's name followed by '*et al.*,' and the year of publication.

If the author's name is included within the sentence, only the year is included in parentheses after the author's name; e.g. 'Taylor (2015) concluded that....'

Groups of references should be listed chronologically.

- e.g. '.....has been used to a limited extent to observe the presence of microorganisms (de Stigter and Broekhuysen, 1986; Put and Clerkx, 1988; Woltering *et al.*, 2001).'

Groups of references in the same year should be listed alphabetically.

- e.g. '...that cavitation causes resistance to xylem flow (Milburn, 1998; Nardinee, 1998; Tyree, 1998).'

Separate multiple citations by a semi-colon

- e.g. (Brown, 2001; Smith, 2016)

Multiple works by the same author

- e.g. '... rivers of Sri Lanka (Dasanayake, 2004, 2006).'

Multiple works by the same author, published in the same year

- e.g. '... rivers of Sri Lanka (Dasanayaka, 1996a, 1996b).'

Ensure that every reference cited in the text is also present in the list of references. Unpublished results and personal communications can be mentioned in the text without adding in reference list. **Personal communications** should be cited in text as follows:

- e.g. Liposomal encapsulation enhances the antioxidant potency of lycopene (J. Smith, personal communication).

Place the in-text citation at the end of a sentence, before the concluding punctuation.

- e.g. '... anxiety about the cultural effects of globalisation (Smith, 2016).'

Or, if the citation refers to only part of a sentence, place it at the end of the clause or phrase to which it relates.

- e.g. 'This was not the case prior to 1974 (James, 2001), however'

If there is no date provided for a source, the abbreviation **n.d.** may be used.

- e.g. (Jones, n.d.)

If there is no discernible author, the title and date are used

- e.g. 'In Career Guidance (2004) this has been explained ...'

All references (i.e. in text and list of references) should be formatted properly before submitting the article.

Therefore, pay attention to the following section to correctly list references.

List of References:

The reference list is arranged alphabetically by author. If an item has no author, it is cited by title, and included in the alphabetical list using the first significant word of the title.

If you have more than one item with the same author, list the items chronologically, starting with the earliest publication.

More than one reference from the same author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.

For electronic sources, use angle brackets (<>) to isolate the web address/URL from the rest of the reference.

See the following examples.

Book

Author(s) of book- family name, initials (year of publication). Title of Book, Edition- edn., Publisher, Place of publication.

e.g. Berkman, R.I. (1994). Find It Fast: How to Uncover Expert Information on Any Subject, Harper Perennial, New York.

If more than one author:

e.g. Jull, G., Sterling, M., Fallah, D., Treleaven, J. and O'Leary, S. (2008). Whiplash Headache and Neck Pain: Research-Based Directions for Physical Therapies, Churchill Livingstone, Edinburgh.

Book by an organization or institution (corporate author)

Corporate author name (Year of publication). Title of book, Edition, Publisher, Place of publication.

e.g. Australian Government Publishing Service (1987). Commonwealth Printing and Publishing Manual, 2ndedn., A.G.P.S., Canberra.

Chapter in an edited book

Mettam, G.R. and Adams, L.B. (1999). How to prepare an electronic version of your article, In: Jones, B.S., Smith, R.Z. (Eds.), Introduction to the Electronic Age. E-Publishing Inc., New York. pp. 281-304.

Journal articles

Author(s) of article- family name, initials (year of publication). Title of article. *Journal name*- Italicise, **Volume number**- bold, (Issue number), page range.

e.g. Van der Geer, J., Hanraads, J.A.J. and Lupton, R.A. (2000). The art of writing a scientific article. *Journal of Science Communication*, **163**, 51-59.

Published conference paper

Author(s) of paper- family name and initials (year of publication). Title of paper, Title of Published Proceedings, Publisher, Place of publication, Page number(s).

e.g. Bourassa, S. (1999). Effects of child care on young children. Proceedings of the Third Annual Meeting of the International Society for Child Psychology, International Society for Child Psychology, Atlanta, Georgia, pp. 44-46.

Unpublished conference paper

Use this for *unpublished* papers and abstracts presented at conferences, seminars and meetings:
e.g. Bowden, F.J. and Fairley, C.K. (1996). Endemic STDs in the Northern Territory: estimations of effective rates of partner change, Paper presented to the scientific meeting of the Royal Australian College of Physicians, Darwin, 24-25 June.

Newspapers and Magazines

Author(s) of article- family name and initials (Year). Title of article, *Title of Newspaper or Magazine*- Italicized, Day, Month, Page number(s).

e.g. Cook, D. (2001). All in the mind, *The Age*, 28 January, p.8

Theses

Author of thesis- family name and initials (year). Title of Thesis, Award, Institution issuing degree, Location of institution (city, country)

e.g. Exelby, H.R.A. (1997). Aspects of Gold and Mineral Liberation, PhD Thesis, University of Queensland, Brisbane, Australia.

Reports

Print:

Author(s) of report- (person or organisation) (Year of Publication). Title of report, Report number (if available), Publisher/ Institution, Place of publication.

e.g. Mortimer, M. and Cox, M. (1999). Contaminants in mud crabs and sediments from the Maroochy River, Environment Technical Report No. 25, Queensland Department of the Environment, Brisbane.

Electronic:

Author(s) of report- (person or organisation) (Year of Publication), Title of report, Description of report (if applicable), Report number (if available), Publisher/ Institution, Place of publication. [Accessed date (Day Month Year)]. Available at <URL>.

e.g. Australian Institute of Health and Welfare (2010). Child protection Australia 2008-09, Child Welfare Series No. 47. Cat. No. CWS 35, Australian Institute of Health and Welfare, Canberra. [Accessed on 06.11.2012]. Available at <<https://www.aihw.gov.au/reports/child-protection/child-protection-australia-2008-09/contents/table-of-contents>>.

Web pages/ Websites/ Web documents

Author(s) of page- (person or organisation) (Year)- (page created or revised), Title of page, Publisher, sponsor or host of the webpage (if available), Place of publication of the webpage (if available). [Accessed on dd mm yyyy]. Available at <URL>.

e.g. Dugdale, S., Holeton, R., Finkelstein, A., Johnston, J. and Smith, R. (2018). 7 Things you should know about emerging classroom technologies, Educause [Accessed on 29.06.2018]. Available at <<https://library.educause.edu/resources/2018/4/7-things-you-should-know-about-emerging-classroom-technologies>>.

Web page/ website with no author:

Where there is no identifiable author or authoring body, use the title of the webpage or website.
e.g. Behaviour modification (2007). [Accessed 31.08.2011]. Available at <<http://www.educational.org.uk/behaviour.html>>.

Web page/ website with institutional or organizational author

The author may be a corporate body or organisation responsible for creating, producing or publishing a webpage or website. Then the author and the publisher is the same.
e.g. Queensland Health (2017). Sun safety and physical activity, Queensland Government [Accessed on 11.12.2017]. Available at <<http://conditions.health.qld.gov.au/HealthCondition/condition/20/199/134/sun-safety-and-physical-activity>>.

Format for typesetting

General Formatting:

- Paper size: A4 (210 X 297 mm) typed single sided only
- Margins: Top, bottom and right margins of 1 inch and a left margin of 1.5 inches
- **Line spacing: Single line spacing throughout the text**
- **Alignment: Justified**
- Columns- Abstract: single column, body: double column
- Length: Length of the manuscript including text, tables, figures and references should not exceed 5 typed pages. You should submit 4 or 5 full pages without empty space
- Page numbering: All pages should be sequentially numbered using Arabic Numbers (bottom of page, centered)
- **Font: Times New Roman (TNR) font, size 10**
- Language/spelling: British English only
- Software: MS Word® 2013 or later version

Specific Formatting:

Title: The title should be in **bold, Title Case and centered**, font size 14

Abstract: 250 words typed in **bold**, single column and justified, TNR font, size 9

Headings: All headings should be in **bold, UPPERCASE and centered**, font size 10
e.g. **INTRODUCTION**

Sub-headings: All subheadings should be in **bold, italic** and in **Title Case**, font size 10
e.g. ***Preparation of Land***

Sub-Sub headings: Sub-sub headings must be in **italic** and **Title Case, Not bold**, font size 10.
e.g. ***Bulk Density***

Header:

First page: Proceedings of 19th Agricultural Research Symposium (2020) p1- p5

Even pages: Authors' names

Two Authors- e.g. Pamunuwa and Karunaratne

More than two authors- e.g. Pamunuwa *et al.*

Odd pages: Running title (5- 7 words in a single line)

Reference for formatting:

Annexure 1: Sample paper (Asif *et al.*, 2018).

Submission

The first author should upload the final version of his/ her manuscript as a MS Word document to the **E-Learning Gateway ELG** after getting the consent of his/ her supervisor/s.

Date: 23rd December 2020

Time: before 11.59 p.m.

Dr P.S. Warakagoda
Coordinator/ Publication Committee
19th AGRES- 2020

Top margin 1 inch

Font 14, Bold, Center,
Title Case, Single space**Development of a Jackfruit-Based Vegetarian Finger
Enriched with Vegetable Protein**Font 10, Center,
UppercaseM.N.M. ASIF¹, M. BULATHKANDAGE², R.H.M.K. RATNAYAKE¹ and K.H. SARANANDA³¹*Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management,
Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka*³*Department of Biosystems Engineering, Faculty of Agriculture and Plantation Management,
Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka*²*Fruit Research and Development Institute, Kananwila, Horana, 12400, Sri Lanka*Full postal address
of authors, Font 9,
Center, Italic,
Single line space**ABSTRACT**

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An attempt was made to develop a vegetarian finger (sausage) as (by-product of soy milk manufacturing). The sausage mix was first prepared (w/w) with 60 % Jack fruit flakes (variety Fatherlong), 5 % rice flour, 5 % solid fat, and the remaining 30 % from different proportions of rice flour and soy flour. The product was subject to sensory evaluation and the best treatment was selected as the binding agent (BA) as different proportions of rice flour and soy flour to fill 5 % of the weight of sausage mix. The final product was again evaluated for its sensory attributes using 30 panellists. The new product was subject to sensory evaluation, proximate analysis, physicochemical and mechanical tests against the existing jackfruit finger formulation developed by Fruit Research and Development Institute (FRDI formulation; Control). A mixture of 25 % okara flour and 5% mushroom as VP and 5 % soy flour as the BA (5 % w/w) was selected as the best formulation. Protein content was 7.73 % which was a 73 % increase compared to the control. Other nutritional properties of jackfruit finger were in the acceptable range. Microbial counts after 30 days of storage remained below the harmful levels. However, rancidity (peroxide value of 13.19 units) after 30 days of storage. Therefore, the storability of jackfruit finger should be improved.

Font 9, Sentence case,
Alphabetical order, Max.
5 words

Tab 0.3 inch.

KEYWORDS: Jackfruit, Mushroom, Okara flour, Vegetable protein (VP), Vegetarian finger**INTRODUCTION**Font 10, Bold,
Center, Uppercase

Postharvest losses of fruits and vegetables in Sri Lanka are as high as 30 – 40 %. The shelf life of many fresh products does not exceed 6 - 7 days due mainly to postharvest diseases (Kodippili, 2016). Development of value added products from fruits and vegetables will minimize the losses while providing economic returns. Moreover, due to the urbanization and busy lifestyle in the modern society, the demand for ready-to-cook food is in the rise (Anon, 2006). Meantime, there is an increasing trend towards vegetarianism.

Jackfruit finger made from jackfruit could gain popularity, especially among vegetarians.

The Fruit Research and Development Centre (FRDC) of the Department of Agriculture (DOA) has taken attempts to develop a vegetarian finger (vegetable sausage) with jackfruit. However, it is difficult to balance the nutrients and improve the palatability of vegetarian jackfruit finger by incorporating protein from other plant sources. The already produced jackfruit finger contains mushroom and sprouted mung bean as protein sources (unpublished data). Nonetheless, it is to be enhanced to make it comparable with its non-vegetarian counterparts. Therefore, in this study, vegetable protein (VP) from soybean was added in the making of jackfruit finger. The properties of final product and sensory attributes were also assessed.

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Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the major fruits of the Wet Zone of Sri Lanka. It is used both as a vegetable (young and mature fruit) and fruit (ripe fruit). Raw jackfruit flesh is a good source of carbohydrate (25 %), vitamin A and a fair source of protein (1.6 %) (Morton and Julia, 1987). The juicy pulp of ripe fruit is eaten fresh as a dessert (Bhatia, 1995).

Jackfruit goes waste in Sri Lanka due to poor harvesting methods and sub-standard modes of bulk transport, thereby resulting in decreased keeping quality. While the processed products from jackfruit are scarce in Sri Lanka, there is a potential for novel value added products. Therefore, a vegetarian finger

METHODOLOGY**Locations and Sample Collection**

Product preparations were done at the FRDC, Horana. Sensory evaluations and microbiological analyses were performed at the Department of Horticulture and Plantation Management, Wayamba University of Sri Lanka, Makandura from June to November, 2018.

Bottom, Centre

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Jackfruit variety Fatherlong was obtained from the FRDC home garden in Horana (WL₁). Variety Fatherlong has proved to be a better variety for processing compared to other local varieties such as Maharagama, Kothmale and Herosa (Personal communication). Fruits at physiological maturity were manually harvested and to the Food Technology Laboratory, where, the fruit and seeds were stored under strict hygienic conditions.

Preparation of Jackfruit Finger (Sausage)

Ingredients of the jackfruit finger produced at FRDI were jackfruit flakes (60 %), mushroom (20 %), sprouted mung bean (10 %), solid fat (5 %), rice flour (5 %) and spices. Jackfruit flakes, mushroom and sprouted mung bean were steamed separately. Cooked items and other ingredients were ground minced in bulk using a Mincer. The mixture was made into fingers using a sausage filler and the sausages were steamed for 45 min followed by freezing. This existing mixture was used as the control throughout the study.

Addition of Vegetable Protein (VP) – Experiment 1

When making the new sausage mix, the contents (w/w) of Jackfruit flakes (60 %), rice flour (5 %) were kept constant and 5 % was made by solid fat and mushroom (40 %) and sprouted mung bean (Table 1). Sprouted mung bean was replaced by VP from “okara flour” which is a by-product in soy milk manufacturing.

Table 1. Treatment combinations for adding protein sources to jackfruit finger

Treatment	% of Mushroom	% of Okara flour
T1	25	5
T2	20	10
T3	15	15
T4	10	20
T5	5	25
T6 (Control)	20	10*

*T6-Contains sprouted mung bean instead of okara flour

Improvement of Binding Ability – Experiment 2

The best sausage mix from Experiment 1 was used to evaluate the efficacy of two binding agents, soybean flour and rice flour, which consisted of 5% of the sausage mix. The two flour types were combined as given in Table 2. The best flour type was used to replace the 5 % rice flour which was used in the control.

Sensory Evaluation

Sensory evaluation of the sausage samples was carried out on parameters such as color, texture, taste, juiciness, and overall acceptability. The samples were evaluated by 20 panelists on a 9-point scale where 1 = “dislike extremely” and 9 = “like extremely”. The samples were evaluated immediately after preparation and after 1 day of storage.

Table 2. Treatment combinations of rice flour and soybean flour as binding agents (BA) in jackfruit finger

Treatment	% Rice flour	% Soy flour
BA1	100	0
BA2	70	30
BA3	50	50
BA4	30	70
BA5	0	100

BA6 – Rice flour (100%) with sausage mix developed by FRDC (Control)

Proximate Analysis of Jackfruit Finger

The proximate composition including moisture, crude protein (N x 6.25), ash contents, and fat contents were determined using Association of Official Agricultural Chemists (AOAC, 2000), and the carbohydrate was measured as given by Grizotto *et al.* (2011).

Estimation of Energy Values

Total calorie estimates (kcal) for uncooked sausage were calculated on the basis of a 100 g sample using at water values for fat (9 kcal g⁻¹), protein (4.02 kcal g⁻¹) and carbohydrate (4 kcal g⁻¹) (Mansour and Grizotto, 2011). The energy value was calculated as follows: Energy (kcal) = (Carbohydrate x 3.87) + (Protein x 4.02) + (Fat contents x 9)

Physicochemical and Mechanical Properties

Emulsion stability was determined using 45 - 50 g of the sausage mix placed in an impermeable, heat-resistant plastic bag, which was sealed and immersed in a water bath at 70°C for 1 h and then cooled. The solid parts of the batter were weighed, and the emulsion stability was expressed as % loss in the form of juice. The lower the % loss of juice, the greater the emulsion stability (Grizotto *et al.*, 2011).

The sausage weight loss during cooking was determined by weighing the product before heat treatment and after cooling (Grizotto *et al.*, 2011). Firmness of sample (Shear force) was determined using a Texturometer (Model: EZ-SX, Shimadzu Corporation, Japan) with 3 mm thick Warner Bratzler device for the cross-section of the entire sample by EZ Test, Texture Expert software 2007.

Font 10, Centre, Author names should be in Header of even pages

Use “Insert -> Table” in MS Word to draw a table. Keep only main horizontal lines. Delete all vertical lines.

Left-justify

Font >8, Right-justify

Font 10, Bold, Sentence case, Single line space

Table footnote- Font 9, Italic

Font >8, Bold, Center

Only main horizontal lines

Running title in Odd Pages, Font 10,
Title Case, Centre,

Use "Insert -> Picture" to include
figures as high resolution
images; e.g. .tiff/.bmp.
Figure caption- below the figure
Font 9, Bold, Single line space

Rancidity

Quality of jackfruit finger was assessed after a storage period of 1, 1.5 and 2 months in the deep freezer (-21°C). Microbial contamination was assessed by Total plate count were (Bala and

Descriptions bellow figure-
Font 9, Italic

using a pH meter (Horiba laqua F70, Horiba Ltd, 2015). Rancidity as the Peroxide value was determined according to the method described by AOAC (AOAC, 2000).

Experimental Design and Statistical Analysis

Experiments were arranged in completely randomized design (CRD). Three sub samples each from new jackfruit finger formulation and from the control were used for proximate analysis and other physicochemical analyses.

Results of sensory evaluations were analyzed using Friedman test. Data on proximate analysis and other chemical tests were analyzed with ANOVA technique and the mean comparisons were done with Tukey' Test at 0.05% level of probability using MiniTab (2018) statistical software.

RESULTS AND DISCUSSION

Addition of Vegetable Protein (VP)

Okara flour was incorporated in different proportions as the protein source in jackfruit fingers. All combinations of mushroom and okara flour obtained higher preferences compared to the control (*i.e.* mung bean sprouts, Figure 1). However, the sensory attributes were not significantly different among the treatments. Therefore, the combination of 5 % mushroom and 25 % okara flour was selected for further experiments considering the higher nutritional value of okara flour and its economic feasibility including lower cost of production.

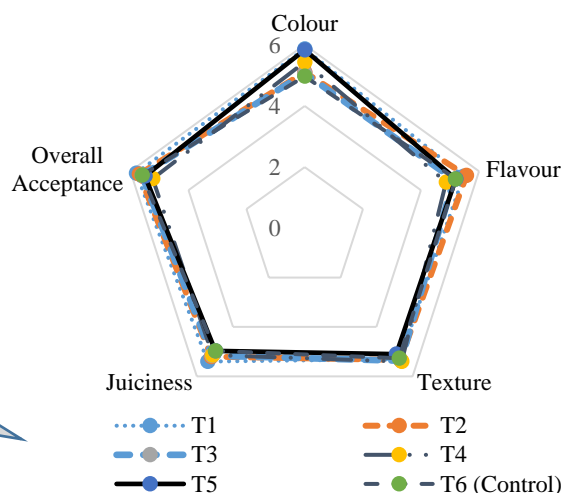


Figure 1. Mean scores obtained from Fried Mann test for sensory attributes in jackfruit fingers in Experiment 1.

T1: 5 % Okara + 25 % Mushroom, T2: 10 % Okara + 20 % Mushroom, T3: 15 % Okara + 15 % Mushroom, T4: 20 % Okara + 10 % Mushroom, T5: 25 % Okara + 5 % mushroom, T6: FRDI developed formulation (Control)

Addition of Binding Agents (BA)

Rice flour and soy flour were added in different proportions as binding agents. Addition BAs made fingers easy to pan-fry. Sensory scores were significantly different ($p < 0.05$) among treatments for attributes of Aroma, Texture, Taste, Overall acceptance and Purchasing intension. The jackfruit finger containing 70 % rice flour and 30 % soy flour (T2) resulted in significantly higher overall acceptability and purchasing intention compared to other treatments (Figure 2).

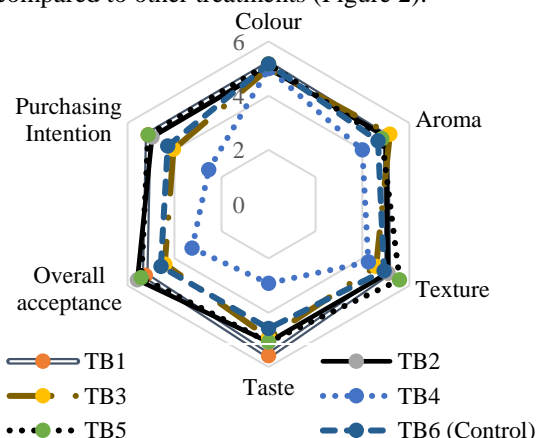


Figure 2. Mean scores obtained for sensory attributes in jackfruit fingers in Experiment 2
BA1: 100 % Rice flour, BA2: 70 % Rice flour + 30 % Soy flour, BA3: 50 % Rice flour + 50 % Soy flour, BA4: 30 % Rice flour + 70 % Soy flour, BA5: 100 % Soy flour, BA6: FRDI developed formulation (Control)

Furthermore, it was observed that pan frying of fingers was quicker and easier with that combination. This combination was therefore, used as the binding agent in jackfruit finger preparation for further tests.

Proximate Composition

Results of proximate analysis are presented in Table 3. The contents of moisture, fiber, protein and carbohydrates were significantly different ($p < 0.05$) between the VP enhanced new formulation and existing control.

Table 3. Variation of Physicochemical properties of vegetarian finger

	Treatments	
	FRDI formulation (Control) \pm SE	VP enhanced formulation \pm SE
Moisture%	41.78 ^a \pm 0.02	33.28 ^b \pm 0.50
Ash%	1.56 ^a \pm 0.02	1.44 ^a \pm 0.07
Fat %	19.25 ^a \pm 0.57	13.99 ^b \pm 0.28
Fiber %	6.32 ^a \pm 0.13	2.62 ^b \pm 1.90
Protein %	4.46 ^a \pm 0.04	7.73 ^b \pm 0.06
Carbohydrates%	26.63 ^a \pm 0.59	40.94 ^b \pm 0.16
Frying Loss %	15.79 ^a \pm 1.25	17.18 ^a \pm 2.06
Steaming loss %	4.52 ^a \pm 0.58	4.87 ^a \pm 0.42

Between columns, values followed by different superscript letters are significantly different at $p=0.05$. * kcal / 100 g of raw jackfruit finger, SE: Standard Error

The protein content was 73 % higher in VP enhanced formulation (7.73 %) compared to that of control (2.62 %). The higher protein content (24 %) and fibre content (52 %) of dried okara could be attributed to this (Rinaldi *et al.*, 2000). However, the fat content of the new finger formulation was 23 % lower than the control (Table 3).

Moisture content of the control was higher than that of VP enhanced jackfruit finger. The moisture level in vegetable fingers could vary between 30 – 35 % (K.H. Sarananda, Personal communication). Therefore, the new jackfruit finger formulation has acceptable level of moisture (Table 3). Moreover, according to ISO 1442 standards, the acceptable moisture content of meat sausages should be <53 % (ISO 1442; I.O.F. Standardization, 1997).

The energy given by 100 g of uncooked finger was not significantly different ($p > 0.05$) between two formulations (Table 3).

Physicochemical and Mechanical Properties

The percentage loss of juice was 1.24 % and 1.19 % in the VP enhanced jackfruit finger and control, respectively (Table 3). Therefore, these sausage formulations could be considered as stable emulsions. Formulations with okara

flour could be expected to have higher values for emulsion stability than those with mung bean sprouts (Grizotto *et al.*, 2011).

Table 4. Physical and mechanical properties of jackfruit finger

		FRDI formulation (Control) \pm SE	VP enhanced formulation \pm SE
Frying /Steaming loss			
Steam %		15.79 ^a \pm 1.25	17.18 ^a \pm 2.06
Fry %		4.52 ^a \pm 0.58	4.87 ^a \pm 0.42
Firmness/Texture (N)			
Fresh		0.44 ^a \pm 0.07	0.57 ^a \pm 0.12
Steamed		0.66 ^a \pm 0.18	0.42 ^a \pm 0.07
Fried		1.23 ^a \pm 0.05	1.58 ^a \pm 1.70
Colour			
Fresh	L*	55.30 ^a \pm 2.40	52.17 ^b \pm 0.08
	a*	9.30 ^a \pm 0.35	8.07 ^a \pm 0.33
	b*	21.33 ^a \pm 1.50	19.97 ^b \pm 1.20
Steamed	L*	37.17 ^a \pm 1.38	49.43 ^b \pm 0.26
	a*	10.27 ^a \pm 0.13	10.33 ^a \pm 0.12
	b*	19.13 ^a \pm 2.57	25.17 ^a \pm 0.88
Fried	L*	33.80 ^a \pm 1.10	32.70 ^a \pm 0.35
	a*	15.13 ^a \pm 4.37	15.00 ^a \pm 0.65
	b*	19.30 ^a \pm 4.40	15.23 ^b \pm 2.22

Between columns, values followed by different superscript letters are significantly different at $p=0.05$, SE: Standard Error

The colours of VP enhanced jackfruit finger and control finger, in the fresh form and after steaming and frying, have been compared in Table 4. Fresh fingers' a*(red green) values were not significantly different ($p > 0.05$). During the steaming process mung bean sprouts turned brown and therefore, the control finger gave a different result in L*(darkness and lightness) value after steaming. On the other hand, fried samples gave significantly different result in b*(yellow blue) value because during frying the VP enhanced finger turned to golden yellow colour compared to the control (Table 4).

Microbial contamination, pH and Rancidity after Storage Period

Microbial population of less than 1000 CFU ml⁻¹ is considered as safe for consumption (Lolong *et al.*, 1987). After 45 days of storage,

The microbial counts were 100 CFU mL⁻¹ (Table 5). pH value of the treatments did not considerably change during the storage period. However, the peroxide value (POV) has considerably increased during storage period. Freshly refined fat would have a POV of < 1 unit. A fat which has a POV greater than 10 units is considered rancid. (Allen and Hamilton, 1994). Accordingly, after 30 day of storage VP enhanced finger became rancid. Therefore,

further studies should be focused on improving the storability of jackfruit finger.

Table 5. Quality of jackfruit fingers after storage at -21°C

Trt	Storage period (Days)	Microbial count (CFU mL ⁻¹)		pH	POV
		TPC	Y-M		
T ₁	0	10 ¹	0	5.86	N
	15	10 ¹	10 ¹	5.86	1.50
	30	10 ²	10 ²	5.85	5.62
	45	10 ²	10 ²	5.83	13.33
T ₂	0	10 ¹	10 ¹	5.45	N
	15	10 ¹	10 ¹	5.39	6.61
	30	10 ²	10 ²	5.35	13.19
	45	10 ²	10 ²	5.30	16.66

Trt: Treatments, T1: FRDI formulation (Control), T2: VP Enhanced formulation, TPC: Total Plate Count, Y-M: Yeast and Mould count, POV: Peroxide value, N: Not detected.

CONCLUSIONS

Protein content of the vegetarian jackfruit finger was improved by the combination of 60 % jackfruit, 25 % okara, 5 % Mushroom, 5 % Solid Fat, 4 % Rice flour and 1 % Soy flour. Nutritional, physical and mechanical properties of jackfruit finger are in the acceptable range. Further studies are recommended on improving the storability of jackfruit finger. Commercial trials and market research are also necessary.

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Maximum number of pages = 05