Optimization of Composite Fruit Peel Powder as a Texture Modifier for Fat Free Set Yoghurt: A Mixture Design Approach

P.G.I. Dias¹, J.W.A. Sajiwanie¹, R.M.U.S.K. Rathnayaka¹* and O. O. Awolu²

Received: 6th February 2020 / Accepted: 18th February 2021

ABSTRACT

Purpose: Fruit waste (FW) is a leading food waste type generates globally. Industrial management of such FW is a great challenge. Since those wastes are rich in nutrients, phytochemicals, and other functional compounds, they can be reused by value addition. In the present study, composite fruit peel powder was formulated and optimised from the FW collected from leading fruit processing industries in Sri Lanka. This powder was utilized as a texture modifier in fat free yoghurt to minimise the whey off.

Research Method: The experiment was carried out using an optimal mixture design of response surface methodology (Design Expert, 8.0.3.1 trial version) for sixteen composite samples. The independent variables were passion fruit peel (FFPP) (60.00–70.00 g/100 g), pineapple peel (PPP) (20.00–30.00 g/100 g), and orange peel (OPP) (10.00–20.00 g/100 g) powders. The dependent variables were proximate composition (fibre, fat, and ash contents), physiochemical (colour values), and technological (bulk density, swelling capacity, oil holding capacity, water holding capacity) properties.

Findings: Results of the ANOVA test showed that the model and model terms significantly affect (P≤0.05) all the parameters except bulk density and oil holding capacity. The contour plots showed that the orange peel largely contributes to the fibre, fat, ash contents and redness (a*) while passion fruit peels highly contribute to the lightness (L*) and water holding capacity. PFPP (60%), OPP (20%) and PPP (20%) were selected as optimum blend due to high fibre content, water holding capacity, and lightness along with less fat content.

Originality/Value: Accordingly, it is possible to optimise some quality parameters of fruit peel powders by compositing them.

Keywords: composite powder, fruit peel, mixture design

INTRODUCTION

Product development is the lifeblood of the food industry (MacFie, 2007). This covers the complete process of bringing a new or modified product to the market stage from idea generation. In this process, suitable experimental designs and statistical methods are vital. The experimental design is a systematic approach to apply statistical methods to experimental processes (e.g. production process/prototype development stages) to improve input-output factors and process parameters (Anon, 2018). This is usually used as a methodology for selecting the levels of independent factors that provide the least variation on the required quality (Anon, 2018).

Computer aided statistical experimental designs will accelerate food development cycles and reduce research and labour costs (Hu, 2017).

In food product development, the factorial design is used to identify the factors affecting certain parameters. Response surface methodology

¹Department of Food Science and Technology, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, P.O.Box 02, Belihuloya, Sri Lanka
udayarathnayaka@gmail.com

²Department of Food Science and Technology, Federal University of Technology, Akure, Nigeria

©ORCID http://orcid.org/0000-0002-9713-7112
(RSM) is used to optimize such factors in order to obtain the most appropriate value for response. RSM reduces the number of experimental trials required in multi-factor experiments (Bai et al., 2015). Mixture design, a special type of RSM, is a very effective method of determining the proportions of variables (ingredients) of a blend. This has been implemented successfully in real-world problems (Sahin, Demirtas, & Burnak, 2016) such as optimising food additives content (Gama et al., 2019) and bioactivities of functional foods (Bertin et al., 2020).

Nearly 80% of local fruit manufacturing industries either incinerate/bury their fruit wastes. Among them, fruit peels are the major waste type (Dias et al., 2020b). They are rich in nutritional and functional properties (Dias et al., 2020c; Gheribi et al., 2019; Lasano et al., 2019), hence, have a possibility to add values and recycle within the food industry. Numerous researches evaluate the potentials of add value to the fruit peels (Ali et al., 2019; de Faria Arquelau et al., 2019; Hanani et al., 2019). Modifying and enhancing the yoghurt texture by adding fruit peel powders like pineapple and passion fruit along are also reported (do Espírito Santo et al., 2012; Sah et al., 2016). By compositing peel powders, a researcher may combine different functional characteristics together which would be valuable for industrial end users.

Eliminating milk fat is vital in the dietary management of non-communicable diseases. However, texture deformation and large whey separation were observed in yoghurt as milk fat and added sugar elimination (Dias et al., 2020a). Fibre rich peel powders usually having high water holding capacity, hence can be used to minimize additional whey off. The current study is focused on developing fruit peel powder composite with optimum such properties with appealing colour to the incorporation.

MATERIALS AND METHODS

Proximate composition, physiochemical, and technological properties

Proximate compositions were determined by calculation methods based on the values obtained for individual peels by AOAC methods (Howitz, 2000). The colour of the samples was measured using a Hunter Lab colour meter (CR 400, Conika Minolta, Japan). Colour was expressed in Hunter Lab units L*, a* and b*, where L* indicates lightness, a* indicates hue on a green (−) to red (+) axis, and b* indicates hue on a blue (−) to yellow (+) axis (Ozcan and Kurtuldu, 2014). Technological properties were evaluated according to the methods of Acuna et al. (2012) with slight modifications. Yoghurt formulation and its quality attributes were reported in a separate paper (Dias et al., 2020d).

Statistical analysis

The experimental design was carried out using the optimal mixture design of response surface methodology (Design Expert, 8.0.3.1 trial version) which resulted in sixteen composite samples (Table 01). The independent variables were passion fruit peel (FFPP) (60.00–70.00 g/100 g), pineapple peel (PPP) (20.00–30.00 g/100 g), and orange peel (OPP) (10.00–20.00 g/100 g) powders. The dependent variables were the proximate composition (fibre, fat, and ash contents), physiochemical (colour values), and technological (bulk density, swelling capacity, oil holding capacity, water holding capacity) properties.

In this study, interaction effects of passion fruit peel (A), orange peel (B), and pineapple peel (C) on selected dependant variable were tested. The test hypothesis as follows; Ho = Interaction effects of peel powders on the dependant variable are significant

H_A = Interaction effects of peel powders on the dependant variable are not significant

If the p value p ≤ 0.05 then, H_o (Null hypothesis) will be accepted and H_A (alternative hypothesis) rejected (Table 02).
Table 01: Values for the independent variables of composite runs

| Sample | PFPP% | OPP% | PPP% | Fibre% | Fat% | Ash% | SC % | BD g/ml | WHC ml/g | OHC ml/g | L* | a* | b* |
|--------|-------|------|------|--------|------|------|------|---------|----------|----------|----|----|----|
| 1      | 60.00 | 15.00| 25.00| 24.74  | 2.10 | 5.19 | 6.61 | 0.43    | 12.00    | 4.00    | 81.07| 3.48| 21.775|
| 2      | 60.00 | 20.00| 20.00| 27.44  | 2.93 | 5.76 | 7.05 | 0.40    | 16.00    | 6.00    | 79.54| 3.99| 22.23|
| 3      | 60.00 | 16.66| 23.33| 26.92  | 3.20 | 5.66 | 7.35 | 0.42    | 9.07     | 8.00    | 79.82| 3.81| 21.85|
| 4      | 70.00 | 10.00| 20.00| 27.19  | 2.85 | 5.74 | 6.82 | 0.41    | 12.00    | 4.00    | 82.10| 3.28| 22.83|
| 5      | 61.66| 11.66| 26.66| 26.84  | 3.19 | 5.70 | 6.23 | 0.43    | 12.00    | 4.40    | 80.25| 3.29| 22.67|
| 6      | 60.00 | 20.00| 20.00| 27.44  | 2.93 | 5.76 | 7.05 | 0.40    | 16.00    | 6.00    | 79.54| 3.99| 22.23|
| 7      | 60.00 | 10.00| 30.00| 20.23  | 2.45 | 5.77 | 8.44 | 0.41    | 15.80    | 5.58    | 81.27| 3.82| 23.12|
| 8      | 65.00 | 10.00| 25.00| 20.23  | 2.45 | 5.77 | 8.44 | 0.41    | 15.80    | 5.58    | 81.27| 3.82| 23.12|
| 9      | 63.33 | 13.33| 23.33| 26.92  | 2.72 | 5.72 | 5.89 | 0.41    | 16.00    | 6.38    | 80.71| 3.68| 22.59|
| 10     | 65.00 | 15.00| 20.00| 26.58  | 2.82 | 5.68 | 6.99 | 0.41    | 10.00    | 19.07   | 82.24| 3.40| 22.38|
| 11     | 66.66| 13.33| 20.00| 27.20  | 5.78 | 5.78 | 6.70 | 0.42    | 9.01     | 10.00   | 80.35| 3.02| 22.60|
| 12     | 70.00 | 10.00| 20.00| 27.19  | 2.85 | 5.74 | 6.82 | 0.41    | 12.00    | 4.00    | 82.10| 3.28| 22.83|
| 13     | 60.00 | 10.00| 30.00| 20.23  | 2.45 | 5.77 | 8.44 | 0.41    | 15.80    | 5.58    | 77.12| 3.82| 23.12|
| 14     | 65.00 | 10.00| 25.00| 25.91  | 2.20 | 5.65 | 7.50 | 0.41    | 12.00    | 8.80    | 81.27| 3.67| 22.36|
| 15     | 60.00 | 10.00| 30.00| 20.23  | 2.45 | 5.77 | 8.44 | 0.41    | 15.80    | 5.58    | 77.12| 3.82| 23.12|
| 16     | 63.33 | 16.66| 20.00| 27.68  | 3.18 | 5.92 | 5.58 | 0.41    | 9.43     | 7.00    | 80.11| 3.52| 22.34|

*BD= Bulk Density, SC= Swelling Capacity, WHC=Water holding capacity, OHC=Oil holding capacity

Table 02: The summary of the ANOVA for the analyses

| Dependent Variable | Model F value | Model (level of significance) | p-value (p≤ 0.05) | R² value | Adj. R² value |
|--------------------|---------------|-------------------------------|-------------------|----------|---------------|
| Fibre              | 158.84        | Cubic (p≤ 0.0001)             | Linear mixture, AC, BC, AC(A-C), BC(B-C) | 0.9958   | 0.9896        |
| Fat                | 195.50        | Cubic (p≤ 0.0001)             | Linear mixture, AC, BC, ABC, AB (A-B), AC (A-C), BC (B-C) | 0.9915   | 0.9966        |
| Ash                | 10.71         | Cubic (p≤ 0.046)              | Linear mixture, BC,ABC,AC(A-C), BC (B-C) | 0.9414   | 0.8535        |
| SC                 | 12.50         | Cubic (p≤ 0.003)              | Linear mixture, BC, AB (A-B) | 0.9494   | 0.8734        |
| BD                 | 107.87        | Quadratic (P > 0.9275)        | Linear mixture, AB, BC | 0.6118   | 0.4177        |
| WHC                | 62.03         | Cubic (p≤ 0.0001)             | Linear mixture, AB,AC,BC,ABC,AC (A-C), BC(B-C) | 0.9894   | 0.9734        |
| OHC                | 2.19          | Quadratic (P > 0.1358)        | Linear mixture, AB | 0.5232   | 0.2848        |
| L*                 | 39.81         | Quadratic (P <0.0001)         | Linear mixture, AC, BC | 0.9049   | 0.8574        |
| a*                 | 1.18          | Cubic (P <0.0001)             | Linear Mixture, AB, BC, ABC, AB(A-B), AC(A-C), BC(B-C) | 0.9852   | 0.9629        |
| b*                 | 2.58          | Cubic (P <0.0001)             | Linear Mixture Components, AB, AC, BC, ABC, AC(A-C), BC(B-C) | 0.9982   | 0.9954        |
RESULTS AND DISCUSSION

Proximate Composition of Composite Powder Combinations

Fibre content, yoghurts are rich in most macro and micro nutrients but not fibres. Therefore, fibre incorporation is important in nutritional standpoint along with texture formation. Increasing fibre fraction is favourable as nutrient, prebiotic agent, as well as texture modifier in foods. The addition of inulin, pea fibre, and carboxy methyl cellulose, into yoghurts to enhance the texture and rheology also reported (El-Nagar and Brennan, 2001; Meyer et al., 2011).

According to the results, fibre content ranges from 20.23 to 27.68% (Table 01) in different mixtures. When tested individually, fibre contents of orange, passion fruit and pineapple peel powders were 20.14%, 32.85% and 11.66%, respectively (Dias et al, 2020c). The contour plot showed orange peel had the highest contribution for increasing fibre content (Figure 01). The ANOVA showed that the model (cubic) and model terms (Linear mixture, AC, BC, AC(A-C), BC(B-C)) significantly (P≤0.05) affect the fibre content (Table 02).

Fat content: Since the powder will add to fat free yoghurt it is better to have low fat%. Fat content ranged from 2.10% to 3.20% in the mixtures. This is a very low value than fat contents of orange peel (16.20%), but higher than the fat content of pineapple (0.99%) and passion fruit peels (0.47%) (Dias et al, 2020c). The contour plot (Figure 02) showed orange peel largely contributed to the fat content. According to the ANOVA the contribution is significant (Table 02).

Fats from plant origin majorly contain high density lipids, which are healthy. However, milk fat is of animal origin and largely contains unhealthy low density lipids. The amount of fat in the composite powder was also very low. Therefore, they can favourably incorporate into low fat food products.

Ash content: Ash content ranged from 5.19% to 5.92% (Figure 03). The values did not largely deviate from ash contents of orange (4.92%), pineapple (4.56%), and passion fruit peels (6.32%), individually (Dias et al, 2020c). The counter plot showed orange peel was highly responsible for the ash content (Figure 03). According to the ANOVA the contribution was significant (Table 02).

Figure 01: Contour plot showing the effect of passion fruit (A), orange (B), and pineapple (C) composite peel powders on fibre content (Red colour denotes the highest values while dark blue denotes the lowest values).
Physiochemical Properties of Composite Powder Combinations

Yoghurts are white or pale yellow in colour. It is better the additives do not disturb the natural colour of yoghurt, hence consumer preference towards the appearance. Therefore, powder combination having the highest L* and low a* and b* values are most appropriate.

$L*$ value, Passion fruit peels largely contributed to L* values (Figure 04). According to the ANOVA (Table 02), the values were significantly different for model (quadratic) and model terms (AC, BC). The values ranged from 77.12% to 82.26% (Table 01, Figure 04), higher than the L* value of pineapple peel 60.69% (Dias et al, 2020c).

$a*$ value, Orange peels largely contributed to a* values (Figure 05). According to the Table 02, the values were significantly ($p \leq 0.05$) different for model terms, AB, BC, ABC, AB(A-B), AC(A-C) and BC(B-C). The values ranged from 3.02% to 3.98% (Figure 05), and lower than the a* value of orange peel (6.10%) (Dias et al., 2020c).

Figure 02: Contour plot showing the effect of passion fruit (A), orange (B) and pineapple (C) composite peel powders on fat content

Figure 03: Contour plot showing the effect of passion fruit (A), orange (B), and pineapple (C) composite peels on ash content
b* value, Pine apple peels majorly contribution to b* values (Figure 06). According to the Table 02, the values have significant (p≤ 0.05) effects on the model terms AB, AC, BC, ABC, AC(A-C) and BC(B-C). The values ranged from 21.78% to 23.13%, higher than the a* value of passion fruit peel (15.68%) (Dias et al, 2020c).

Figure 04: Contour plot showing the effect of passion fruit(A), orange(B), and pineapple(C) composite peel powders on L* value

Figure 05: Contour plot showing the effect of passion fruit (A), orange(B) and pineapple(C) composite peel powders on a* value

Technological Properties of Composite Powder Combinations

Bulk Density and swelling capacity, Bulk Density

Figure 06: Contour plot showing the effect of passion fruit(A), orange(B), and pineapple(C) composite peel powders on L* value

Figure 07: Contour plot showing the effect of passion fruit(A), orange(B), and pineapple(C) composite peel powders on bulk density

Figure 08: Contour plot showing the effect of passion fruit(A), orange(B), and pineapple(C) composite peel powders on swelling capacity
sugar free yoghurts. However, too much water absorption to fibres can adversely affect the texture and probiotic survival of dairy products.

Water holding capacity values were between 9.01 %/g to 16.00 %/g (Table 01). The addition of passion fruit peel largely contributed to water holding capacity and the effect was significant (P<0.05) according to the ANOVA of cubic model (Figure 09 and Table 02). Oil holding capacity was less influenced by mixing fruit peels (Figure 010). Quadratic model and model terms were not significant except model term AB (Table 02).

Figure 06: Contour plot showing the effect of passion fruit (A), orange (B) and pineapple (C) composite peel powders on b* value

Figure 07: Contour plot showing the effect of passion fruit (A), orange (B) and pineapple (C) composite peel powders on bulk density
Figure 08: Contour plot showing the effect of passion fruit(A), orange(B), and pineapple(C) composite peel powders on swelling capacity

Figure 09: Contour plot showing the effect of passion fruit (A), orange(B), and pineapple(C) composite peel powders on water holding capacity

Figure 010: Contour plot showing the effect of passion fruit(A), orange(B) and pineapple(C) composite peel powders on oil holding capacity
The closer the $R^2$ closer to 1.00, the better (Awolu et al., 2016, 2015). Since $R^2$ value close to 1.00 may also be as a result of an increase in sample numbers, adjusted $R^2$ values are thereby employed to ascertain the fitness of the curve. So a high adjusted $R^2$ value is required (Awolu, 2017). In this case, only fibre, fat, ash, SC, WHC and Lab colour values had high adjusted $R^2$ values that are close to one.

According to Table 01, the highest fibre and water holding capacity were demonstrated by samples 2 and 6. The sample combination was selected for incorporation into fat and sugar free yoghurts. Because, we assumed the two properties can contribute to hold the whey fraction, reduce syneresis and modify texture of yoghurts. The peel combination of the samples is as passion fruit peel, orange peel and pineapple peel were 60%, 20% and 20%, respectively.

Quality attributes of composite peel powder added fat and sugar free set yoghurt was described in a separate paper. Incorporation of 0.5% of fruit peel powder composite reduced whey off by 48.86% (Dias et al., 2020d).

CONCLUSION

Proximate composition, physiochemical and technological properties of fruit peel powders significantly changed by mixing them in different proportions. The contour plots showed that the orange peel largely contributes to the fibre, fat, ash contents and redness (a*) while passion fruit peels highly contribute to the lightness (L*) and water holding capacity. It is possible to optimise some quality parameters of fruit peel powders by compositing them. However, the manufacturer has to select the optimum mixture based on the end product qualities expected. In the present study, PFPP (60%), OPP (20%), and PPP (20%) were selected as optimum blend due to high fibre content, water holding capacity, and lightness along with less fat content as the composite powder incorporate into fat free yoghurt to reduce its whey off.

ACKNOWLEDGEMENT

This work was fully funded by Sabaragamuwa University of Sri Lanka through the attribution of a research grant [SUSL/RG/2017/05]

REFERENCES

Acuna, C., Patricia, S., González, G., Humberto, J., Torres, A., and Dario, I. (2012). Physicochemical characteristics and functional properties of vitabosa (mucuna deeringiana) and soybean (glycine max). Food Science and Technology, 32(1), 98–105. doi:10.1590/S0101-20612012005000007

Ali, A., Chen, Y., Liu, H., Yu, L., Baloch, Z., Khalid, S., Zhu, J. and Chen, L. (2019). Starch-based antimicrobial films functionalized by pomegranate peel. International Journal of Biological Macromolecules, 129, 1120–1126. doi: https://doi.org/10.1016/j.ijbiomac.2018.09.068

Awolu, O.O., (2017). Optimization of the functional characteristics, pasting and rheological properties of pearl millet-based composite flour. Heliyon, 3(2), e00240. doi: https://doi.org/10.1016/j.heliyon.2017.e00240

Awolu, O.O., Oluwaferanmi, P.M., Fafowora, O.I. and Oseyemi, G.F. (2015). Optimization of the extrusion process for the production of ready-to-eat snack from rice, cassava and kersting’s groundnut composite flours. LWT-Food Science and Technology, 64(1), 18–24. doi: https://doi.org/10.1016/j.lwt.2015.05.025

Awolu, O.O., Osemeke, R.O. and Ifesan, B.O.T. (2016). Antioxidant, functional and rheological properties of optimized composite flour, consisting wheat and amaranth seed, brewers’ spent grain and apple pomace. Journal of Food Science and Technology, 53(2), 1151–1163. doi: 10.1007/s13197-015-2121-8
Bai, Y., Saren, G. and Huo, W. (2015). Response surface methodology (RSM) in evaluation of the vitamin C concentrations in microwave treated milk. *Journal of Food Science and Technology*, 52(7), 4647–4651. doi: 10.1007/s13197-014-1505-5

Bertin, M., Rachel, M., Tarcisse, B. N., & Etienne, N. (2020). Optimization by mixture design of the antimicrobial activities of five selected essential oils. *Journal of Medicinal Plants Research*, 14(10), 570–579. doi: https://doi.org/10.5897/JMPR2020.7020

Dias, P.G.I., Sajiwanie, J.W.A., Rathnayaka, R.M.U.S.K. (2020a). Alteration of Basic Quality Attributes of Set Yoghurts as Added Sugar and Milk Fat Reduction. *Asian Food Science Journal*, 17(1), 24–37. doi:10.9734/AFSJ/2020/v17i130183

Dias, P.G.I., Sajiwanie, J.W.A., Rathnayaka, R.M.U.S.K. (2020b). A Study on Fruit Wastage in Mass Scale Fruit Processing Industries in Sri Lanka and their Potential to Reuse. *Food Science and Nutrition Research*, 3(1), 1–6. Retrieved from https://www.semanticscholar.org/paper/A-Study-on-Fruit-Wastage-in-Mass-Scale-Fruit-in-Sri/2830d289363ed9cf75d470b80e1b65977eb0eb6d

Dias, P.G.I., Sajiwanie, J.W.A. and Rathnayake, R.U.M.S.K. (2020c). Chemical Composition, Physicochemical and Technological Properties of Selected Fruit Peels as a Potential Food Source. *International Journal of Fruit Science*, 20, 1-12. doi:10.1080/15538362.20201717402

Dias, P. G. I., Sajiwanie, J.W.A., Rathnayaka, R.M.U.S.K. (2020d). Formulation and development of composite fruit peel powder incorporated fat and sugar-free probiotic set yogurt. *GSC Biological and Pharmaceutical Sciences*, 11(1), 093–099. doi: 10.30574/gscbps.2020.11.1.0084

Espírito Santo, A. P., Perego, P., Converti, A., & Oliveira, M. N. de. (2012). Influence of milk type and addition of passion fruit peel powder on fermentation kinetics, texture profile and bacterial viability in probiotic yoghurts, *LWT*, 47(2), 393–399. doi: https://dx.doi.org/10.1016/j.lwt.2012.01.038

El-Nagar, G. F., & Brennan, C. S. (2001). The relationship between different types of fiber additions (qualitative and quantitative) on fat-free stirred yoghurt rheological. Proc. 8th Egyptian Conference on Dairy Science & Technology, 505, 523.

Faria Arquelau, P.B., Silva, V.D.M., Garcia, M.A.V.T., de Araujo, R.L.B. and Fante, C.A. (2019). Characterization of edible coatings based on ripe “Prata” banana peel flour. *Food Hydrocolloid*, 89(1): 570–578.doi: 10.1016/j.foodhyd.2018.11.029

Gama, A. P., Hung, Y.-C., & Adhikari, K. (2019). Optimization of emulsifier and stabilizer concentrations in a model Peanut-Based beverage system: A mixture design approach. *Foods*, 8(4), 116. doi: 10.3390/foods8040116.

Gheribi, R., Habibi, Y. and Khwaldia, K. (2019). Prickly pear peels as a valuable resource of added-value polysaccharide: Study of structural, functional and film forming properties. *International Journal of Biological Macromolecules* 126: 238–245. doi:10.1016/j.ijbiomac.2018.12.228

Hanani, Z.N., Yee, F.C. and Nor-Khaizura, M.A.R., (2019). Effect of pomegranate (*Punica granatum* L.) peel powder on the antioxidant and antimicrobial properties of fish gelatin films as active packaging. *Food Hydrocolloid*. 89, 253–259. doi:10.1016/j.foodhyd.2018.10.007

Horwitz, W. (2000). Official methods of analysis of AOAC International. Volume I, agricultural chemicals, contaminants, drugs/edited by William Horwitz. Gaithersburg (Maryland): AOAC International
Hu, R. (2017). Food product design: a computer-aided statistical approach. Routledge.

Huang, Y.W. (2007). Identifying critical steps in the new product development process. Accelerating New Food Product Design and Development. 183–182. doi:10.1002/9781119149330.ch16

Lasano, N.F., Hamid, A.H., Karim, R., Dek, M.S.P., Shukri, R., and Shazini Ramli, N. (2019). Nutritional Composition, Anti-Diabetic Properties and Identification of Active Compounds Using UHPLC-ESI-Orbitrap-MS/MS in Mangifera odorata L. Peel and Seed Kernel. Molecules 24(2): 320. doi: 10.3390/molecules24020320

MacFie, H. (2007). Consumer-led food product development. Elsevier.

Meyer, D., Bayarri, S., Tárrega, A., & Costell, E. (2011). Inulin as texture modifier in dairy products. Food Hydrocolloids, 25(8), 1881–1890. doi: https://doi.org/10.1016/j.foodhyd.2011.04.012

Ozcan, T., & Kurtuldu, O. (2014). Influence of dietary fiber addition on the properties of probiotic yogurt. International Journal of Chemical Engineering and Applications, 5(5), 397. doi:10.7763/IJCEA.2014.V5.417

Sah, B. N. P., Vasiljevic, T., McKechnie, S., & Donkor, O. N. (2016). Physicochemical, textural and rheological properties of probiotic yogurt fortified with fibre-rich pineapple peel powder during refrigerated storage. LWT-Food Science and Technology, 65, 978–986. doi: https://doi.org/10.1016/j.lwt.2015.09.027

Şahin, Y.B., Demirtaş, E.A., Burnak, N., 2016. Mixture design: A review of recent applications in the food industry. Pamukkale University Journal of Engineering Science. 22 (4): 297–304. doi: https://dx.doi.org/10.5505/pajes.2015.98598