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RESEARCH ARTICLE

Nutritional Properties of De-fatted Coconut (*Cocos nucifera* L.) Testa Flour Incorporated Sri Lankan Traditional Food: Roti

H.P.D.T. Hewa Pathirana[1*], L.L.W.C. Yalegama[1], A.M.L.Silva[2] and J.M. Nazrim Marikkar[2]

[1]Coconut Processing Research Division, Coconut Research Institute, Lunuwila, Sri Lanka
[2]National Institute of Fundamental studies, Hanthana Road, Kandy
[*]Corresponding Author : H.P.D.T. Hewa Pathirana

ABSTRACT

Coconut testa (brown outer skin of coconut kernel) is a by-product of coconut industry and it does not have proper usage at present. The aim of this research was to evaluate the potential of coconut testa flour (TF) to substitute for wheat flour in preparation of unleavened bread or roti. TF is the ground defatted dehydrated coconut parings obtained from paring oil extraction. The dehydrated brown testa was subjected to oil extraction using cold press expeller followed by grinding into a fine flour. The quality of raw material (testa and TF) was evaluated. The samples of roti were prepared by incorporating 0%, 10%, 20% and 30% of TF instead of wheat flour and the sensory attributes of the roti were evaluated. Functional and proximate composition of flour blends and selected roti samples were compared with a control (100% wheat flour). Fat and moisture contents of dehydrated parings were 58.06% and 4.04% respectively, and the concentrations were reduced to 16.97% and 2.56% respectively while producing TF. All sensory attributes (taste, texture, appearance, smell, overall acceptability) of the TF incorporated roti were significantly different ($P<0.05$) compared to the roti made with 100% wheat flour (WF). According to the results, TF can be successfully substituted for wheat flour up to a level of 20% to enhance nutritional qualities of roti. No significant difference of swelling capacity, bulk density, tapped density and water absorption capacity ($P>0.05$) between the selected flour blend sample (20% TF: 80% WF) and 100% WF sample was observed. However, crude fiber and protein contents of the 20% TF and 80% WF blend were significantly ($P<0.05$) higher than the WF only samples. The TF incorporation (20%) contributed to increase the crude fiber content of roti from 1.81% to 7.04% and protein content from 12.43% to 16.06%.

Keywords: coconut testa flour, wheat flour, unleavened bread, sensory characteristics, functional properties

1. INTRODUCTION

Sri Lankans consume rice and wheat flour-based food as staple food and higher percentage of per capita consumption of wheat flour is recorded among the urban and estate communities compared to the other communities (Jayatissa et al., 2014). The roti (unleavened bread made with wheat flour and shredded coconut) is a traditional food item consumed for breakfast or dinner. However, excessive consumption of wheat flour containing food causes many health hazards such as obesity, heart disease, digestive problems and hyper-insulin response due to the high gluten and starch contents (Ranasinghe et al., 2015). Moreover, there is a direct correlation of refined grains and fast-food patterns with type 2 diabetic among developing countries (Sami et al., 2017). Therefore, diabetic patients are forced to follow a strict gluten-free or low gluten and low starchy diet. Moreover, gluten-sensitive consumers demand for nutritious, low gluten food products (Oniszczuk et al., 2019).

Studies have been conducted to identify potential functional ingredients with low Glycemic Index (GI) values to replace wheat flour. Researchers reported that rice flour, soy flour and kurakkan *(Eleusine coracana)* flour can be substituted in wheat flour based - traditional foods. (Perera et al., 2015, Thathvasuthan et al., 2007). However, there are no evidences of using de-fatted coconut testa flour (TF) as a partial substitute for wheat flour-based food.

Coconut (*Cocos nucifera* L.) is a vital food crop which is a major component of the average Sri Lankan diets and an important crop in the economy of Sri Lanka. It is used for a variety of products which is exported to various countries. Desiccated coconut (DC), Virgin coconut oil (VCO) and Coconut milk are the major processing industries which has a good export potential. Common practice of producing these products is the removal of brown skin or testa of coconut kernel. The brown skin is rich in oil with high oleic acid content compared to the oil of the white kernel.

The testa is used to extract coconut testa oil and the by-product (press cake) is rich in fiber and other nutritional ingredients and suitable for human consumption if processed with hygienic conditions. Appaiah et al., (2014) revealed that whole coconut kernel and coconut testa contain similar proximate composition with slight deviation. The TF has protein 23.82%, fat 10.12 % and carbohydrates 59.21% (Marasinghe et al, 2019). Functional and chemical composition suggest TF can be partially incorporated in place of wheat or rice flour in food preparation.

Coconut TF was produced from testa available in processing industries by sequential removal of water and fat followed by grinding. The bioactive compounds were sequentially extracted using hexane, ethyl acetate and methanol. Methanol extract of all cultivar displayed presence of phenolic compounds and flavonoid compounds such as caffeic acid, chlorogenic acid, gallic acid, ellagic acid, ferulic acid, p-coumaric acid, sinapic acid, vanillic acid, epigallocatechin, gallates, quercetin and rutin. In addition to the presence of above bioactive compounds, it also showed antioxidant and alfa- amylase inhibitory activity (Gunarathne et al, 2022). Extruding of coconut paring flour and wheat flour is possible to make string hopper which is a wheat flour or rice flour based-based extruded product (Rushdha et al, 2022). These reports indicate the suitability of coconut TF for partial substitution of coconut TF for wheat flour.

Therefore, the focus of this research is to find the best level of incorporation of TF to wheat flour for popular unleavened food "roti" to increase the health status of the diet than the roti prepared with wheat flour.

2. METHODOLOGY

2.1. Location and Sample Collection

The research was conducted at the Coconut Processing Research Division (CPRD) of Coconut Research Institute, Lunuwila. Fresh coconut testa was obtained from Desiccated Coconut (DC) mill at Katana, Sri Lanka. All-purpose wheat flour was purchased from a local market.

2.2. Location and Sample Collection

The fresh coconut testa was washed with clean water and drained. Then, it was dried at 70 °C using a cabinet-type dehydrator (Unitex Engineers, Sri Lanka) until moisture content of the testa reached to 5%. Then, oil was extracted using screw press baby oil expeller (Ashoka industries, Sri Lanka) and defatted brown color press cake was collected and ground into a fine powder using a pulverizing machine (FRITSCHPUL-14 Sri Lanka) and the flour was called defatted TF.

2.3. Identification of The Best Level of Defatted TF for *roti* Preparation

A portion of wheat flour was replaced by TF to formulate TF incorporated roti.

Wheat flour, coconut meat and table salt were mixed and water was added to make consistent dough which is kneadable and non-sticky. The dough was flattened to a uniform thickness on a banana leaf and cut into round 15 cm diameter and 5 mm thickness and baked on a flat clay pan using a gas cooker. Once a side of the roti was baked for about 3 minutes, it was turned over to bake for another 2 minutes.

2.4. Data Collection

2.4.1. Quality of Raw Materials

The initial quality of the raw material (testa) was analyzed to determine the free fatty acid content (FFA) and peroxide value (SLSI 2002). The proximate composition of the dehydrated testa and the TF were analyzed for moisture content (AOAC method 990.20: 1999), fat content (Randle method: 945.16), protein content (Kjeldahl method 955.04), and ash (dry ash: 900.02A) content

2.4.2. Evaluation of Sensory Properties of TF Incorporated *roti*

Sensory evaluation was conducted to determine the appearance, odour, taste, texture and overall acceptability of *roti* samples using 25 numbers of semi trained panelists. The panel consisted of females and males of 20 - 50 years of age. The panelists were given written instructions and were explained the purpose of the research. Coded TF incorporated roti samples were served to the panelists randomly. A score of *roti* was ranked by five points hedonic scale (Rank 5 for very like to rank 1 for extremely dislike).

Table 1 : Recipes for TF based roti formulation

Treatment	Wheat flour (g)	Testa flour (g)	Coconut meat (g)	Water (ml)	Salt (g)
Control	100	-	60	30	3.5
R_1	90	10	60	30	3.5
R_2	80	20	60	30	3.5
R_3	70	30	60	30	3.5

samples were served to the panelists randomly. A score of roti was ranked by five points hedonic scale (Rank 5 for very like to rank 1 for extremely dislike).

2.4. 3. Determination of Functional Properties of Composite Flour

Functional properties of the flour blend which was used to prepare best roti (selected through the sensory evaluation) and the flour used to make the control were determined.

Swelling Capacity

Swelling capacity of flour blends was determined according to Okaka & Potter (1977). The flour sample was filled into the 10ml mark in a 100ml stoppered graduated cylinder and volume was made up to the mark of 50 ml with distilled water. Then, the cylinder was closed and mixed by inverting it. The suspension was inverted again after 2 min and allowed to stand for 30 min. The volume occupied by the sample was taken after 30 min.

Bulk Density and Tapped Density

Bulk density of samples was evaluated according to Cynthia et al., (2015) with slight modifications. Ten grams of the flour sample were measured into a 50 ml measuring cylinder and was mixed at a speed of 1500 rpm by vortex vibrator for 1 min. The ratio of mass of the flour and the volume occupied by the sample was calculated as the bulk density of the sample. The cylinder with the same contents was tapped by hand on a bench for 100 times from a height of 10 cm to determine tapped density. The ratio of the mass of the sample to volume occupied by the tapped sample was calculated as the tapped density.

Wettability

The wettability of flour samples was determined according to the method described by Vissotto et al., (2010) by measuring the time required for 1g of flour to deposit on liquid surface until it is completely submerged in 100ml of distilled water placed in 250ml beaker at 25ºC.

Oil Absorption and Water Absorption Capacity

One gram of flour sample was mixed with 100ml of distilled water and 100ml of soybean oil separately in two centrifuge tubes. Then, the samples were kept at room temperature for 30min and were centrifuged at 3000rpm for 30min. The volume of free water and soybean oil were recorded directly from the centrifuged tube. Water absorption and oil absorption were determined as percent water or oil bound per gram of flour.

2.4. 4. Nutritional Composition of (TF) Incorporated roti and Control roti

Moisture, crude fat, crude protein, crude fiber and ash contents of selected roti sample (20%TF) and 100% wheat flour roti were determined according to the methods described in AOAC (1999).

2.5. Data Analysis

Each experiment was carried out with completely randomized design. Data were analyzed using both qualitative and quantitative methods. Non-parametric data were analyzed using Friedman test while parametric data were analyzed using Analysis of variance (ANOVA) using Minitab 17 statistical software package with the 0.05 significant level.

3. RESULTS AND DISCUSSION

3.1. Quality of Raw Materials

The proximate composition of dehydrated coconut testa and TF are presented in Table 2.

Table 2 : Proximate composition of dehydrated coconut testa and TF

Constituent (%)	Dehydrated testa	TF
Moisture	4.04 ± 0.12	2.56 ± 0.12
Fat	58.06 ± 1.40	16.97 ± 2.44
Ash	3.39 ± 0.18	4.87 ± 0.15
Crude fiber	13.79 ± 1.93	23.51 ± 0.94
Crude protein	12.65 ± 0.25	18.02 ± 0.09
Carbohydrates	7.36 ± 0.39	32.80 ± 2.53
Free fatty acid content	1.33±0.02	*NT*
Peroxide value	not detected	*NT*

Results expressed as mean ± SD of triplicate analysis, NT; Not tested

During the drying process, the moisture content of pairing has reduced to 4.04 ± 0.12%, while it further decreased to 2.56 ± 0.12% due to oil extraction process. Moisture content is the major factor which determines the shelf-life stability of processed products (Coultate, 2009). Due to low moisture content (< 3%) of the TF, it has a longer shelf life with low possibility of hydraulic rancidity and microbial growth.

Even though TF is a by-product from oil extraction process, it contains a considerable fat content (16.97± 2.44%). The residual oil in TF can be utilized as an internal fat source when it is used for food preparation. Therefore, addition of fat can be reduced. A previous study reported that the fatty acid distributions of oils extracted from TF of different cultivars of coconut contained 82.5–91.23% saturated fatty acids (SFA) and 8.76–17.5 % unsaturated fatty acid (USFA) (Marasinghe et al., 2019; Appaiah et al., 2014). According to these studies, oil present in coconut TF is low in SFA and high in USFA compared to the oil of whole coconut kernel which contains 94.6% SFA and 5.4% USFA. Therefore, coconut TF is nutritionally an important dietary ingredient.

The free fatty acid (FFA) content of oil extracted in testa is 1.33 ±0.018%, which is generally high compared to the free fatty acid content of coconut flour obtained from white coconut kernel which is the by-product from virgin coconut oil. The coconut flour from white coconut kernel is less than 0.2% as lauric acid (FPDD, Phillipines). Therefore, the processing condition of TF should be improved to bring down the FFA content to below 0.2% value than the FFA content of crude coconut oil (max 0.4%) which is recommended by the APCC standards 2020. Due to uncontrolled way of heating, formation of FFA can occur in brown testa even before the oil is expelled. In contrast, white coconut kernel is processed in a controlled way to reduce FFA formation. Therefore, FFA value of oil present in TF is higher than the oil present in white coconut oil.

Peroxide value indicates extent of peroxide free radicals present in the dehydrated testa. The free radicals of lipid oxidation further produce secondary products such as aldehydes, ketones and alcohols. Results show that there is no peroxide formation in TF.

Ash represents the composite form of minerals present in flour. Mineral content of foods is important because it provides minerals needed by the body. The quality of many foods depends on the concentration and type of minerals they contain. Minerals contribute to taste, appearance, texture and stability of the food. Previous studies showed that ash content of wheat flour varies from 1.17% to 2.96 % (Obert et al., 2004). The data presented in Table 2 shows that ash contents of the TF was 4.87±0.15 % which is also in agreement with the guide of Food Product Development Center on Philippine (FPDD, 2019). It is comparatively higher than wheat flour (WF). Also, it is generally accepted that the ash content of flour does not affect the baking performances (Borla et al., 2004). Therefore, high ash content of TF is safe for food preparations.

According to the results of this study, protein content of coconut pairing and coconut TF were 12.65±0.25 and 18.02±0.09 respectively. Gunathilake et al., (2009) reported that the substitution of WF from non-wheat flour sources could increase the protein content of bakery products. However, the presence of gluten is very essential to build the frame to trap the gases during food leavening. Therefore, substitution of wheat flour from the coconut TF, reduces the gluten content and thereby leavening characteristics of the food is affected. However, non-WF with high protein content has been used for development of food products (Nasir et al., 2020; Setia et al., 2020).

Fiber is an essential therapeutic component in daily diet to prevent from constipation, hemorrhoids, diverticulosis, coronary heart diseases some cancer and maintain body mass index. Based on the recommendation of World Health Organization (2019), adults need to take 25g of fiber daily. Hence, incorporation of fiber rich substances in the daily diet is an essential task to improve healthy life. The coconut TF has 23.51 ± 0.94% of crude fiber. The whole WF contains low concentrations of crude fiber (0.96±0.06%) and substitution of TF from whole WF is a good option to increase fiber content of the diet.

3.2. Sensory Evaluation of TF Incorporated *roti*

The results of sensory evaluation of three coconut *roti* samples which were prepared by incorporating different percentages of TF, namely, 10%, 20% and 30% (W/W) are shown in Figure 1. According to the results, all sensory attributes were significantly affected ($P<0.05$) by the incorporation of TF into the WF for the preparation of *roti* which is an unleavened type of bread. However, there were no significant differences ($P>0.05$) between 10% and 20% TF incorporation for all sensory attributes. However, 10% TF incorporated *roti* showed the highest acceptance for odour (63), taste (62), texture (59) and overall acceptance (62) while better appearance is from 20% TF incorporation. With the reduction of WF proportion in the composite flour, the texture of the *roti* was changed due to low concentration of gluten in the composite flour as gluten imparts essential structural, rheological, and organoleptic properties of the food prepared with WF (Oniszczuk et al., 2019). Results revealed that 20% of TF can be incorporated with 80% of WF as a value addition of TF with enriching the nutritional status of roti. Gunathilake et al., (2009) reported that coconut flour prepared from dehydrated defatted desiccated coconut obtained after extraction of virgin coconut oil could successfully be incorporated at 10 and 20% with WF to prepare bread.

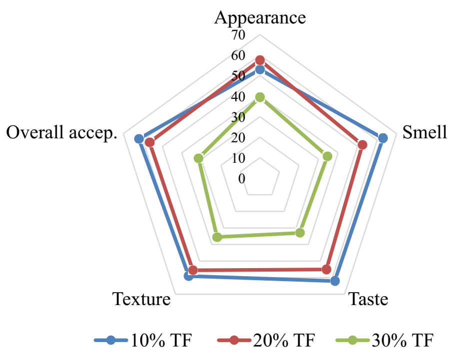

Figure 1: Sum of ranks values of sensory evaluation of TF incorporated *roti*

3.3. Functional Properties of Wheat Flour: Testa Flour Blends

Functional properties of selected WF blends are shown in Table 3. Results showed that there was no significant difference (P>0.05) between selected flour blend (20% TF: 80% WF) with 100% WF for swelling capacity (SC), bulk density (BD), tapped density (TD) and water absorption capacity (WAC).

Table 3 : Functional properties of 20% TF: 80% WF blend and 100% WF *roti* mixtures

Parameters	20% TF+ 80% WF	100%WF
SC (%)	15.67 ± 1.53^a	16.33 ± 1.53^a
BD (g/cc)	0.57 ± 0.01^a	0.52 ± 0.03^a
TD (g/cc)	0.77 ± 0.04^a	0.78 ± 0.02^a
OAC (%)	138.03 ± 4.75^a	116.46 ± 6.98^b
WAC (%)	154.60 ± 9.31^a	134.24 ± 8.33^a
WT (min)	0.34 ± 0.01^a	1.38 ± 0.08^b

The values are mean ± SD of three independent determinations. Means followed by the same letter within a raw are not significantly different at P ≤ 0.05. SC: swelling capacity, BD: bulk density, TD: tapped density, OAC: oil absorption capacity, WAC: water absorption capacity, WT: wettability

Oil absorption capacity (OAC) and wettability (WT) of the flour blend (TF 20: WF 80 blend) and wheat flour were changed significantly (P<0.05). SC, BD, TD and WAC were not changed significantly due to incorporation 20% coconut TF into WF. Incorporation of TF improves the oil absorption capacity with showing repellent action for wetting. Moreover, 100% WF shows high SC (16.33%) than the 20% TF blend (15.67%). The SC of flours depends on size of particles, types of variety and type of processing methods or unit operations. BD has increased (from 0.52 to 0.57%) with the 20% of TF blending. BD depends on the particle size and initial moisture content of flours. BD of flour relates to the suitability for use in various food preparations. Low BD would be an advantage in the formulation of complementary foods (Akapata & Akubor 1999). Suresh et al., (2015) reported that flour composite (55:15:15:15 wheat flour, rice flour, green gram flour and potato flour) with 0.820g/cc BD was suitable for biscuit preparation.

High WAC of composite flour suggests that the flour can be used in the formulation of some foods such as sausage, dough, processed cheese and bakery products. However, WAC is not affected by the addition of TF. Therefore, WAC of the flour blend is suitable for similar applications as WF. The flour with high water absorption may have more hydrophilic constituents such as polysaccharides (Butt & Batool 2010). Coconut flour has high carbohydrate content and crude fibre which are having potential to attract water molecules.

Oil absorption capacity (OAC) of flour blend with 20% TF is higher (138.03 ± 4.75) than the OAC of 100% WF (116.46 ± 6.98). However, Suresh et al (2015) reported that the OAC of flour blend (Wheat, rice, green gram and potato) was increased and a blend with wheat: rice: green gram and potato at 55:15:15:15 with 156±16.73 of OAC is accepted for biscuit preparation. The possible reason for the increase of the OAC of the flour blend after incorporation of TF is due to the variations of the presence of non-polar side chains present in TF, which might bind the hydrocarbon side chain of the oil. The wettability of 20% TF blend is lower (0.34 ± 0.01min) than 100% WF (1.38 ± 0.08min). The possible reason can be the repellent action of the TF blend which contains high oil content.

3.4. Proximate Composition Analysis

Proximate results of selected (20%) TF incorporated roti samples and control samples (100 %WF) are presented in Table 4.

Table 4 : Proximate values of 100 % WF and 20 % TF incorporated *roti*

Constituent (%)	Type of *roti*	
	100% WF	20% TF + 80% WF
Moisture	22.69 ± 0.64[a]	21..48 ± 5.08[a]
Fat	16.66 ± 0.72[a]	15.59 ± 0.43[a]
Ash	3.16 ± 0.18[a]	4.32 ± 0.52[a]
Crude fiber	1.80 ± 0.16[b]	7.04 ± 1.15[a]
Crude protein	12.43 ± 1.14[b]	16.60 ± 1.02[a]
Carbohydrates	*40.08 ± 1.75*[a]	*34.97 ± 4.21*[a]

The values are mean ± SD of three independent determinations. Means followed by the same letter within a raw are not significantly different at P ≤ 0.05. All are expressed on a wet basis TF: Testa flour incorporated roti

According to the results, there was no significant difference (P>0.05) in moisture, fat, ash and carbohydrate content between TF roti and WF roti. Incorporation of 20% of TF affected significantly (P< 0.05) for the fiber and protein content of two treatments. The crude fiber and crude protein content of wheat flour roti has increased respectively from 1.80 ± 0.16% to 7.04 ± 1.15% and 12.43 ± 1.14% to 16.60 ± 1.02% due to the incorporation of 20% TF. Therefore, fortification with TF is more effective due to the nutritional benefits while preserving organoleptic attributes. Due to high dietary fiber and gluten free protein in TF roti, it can be introduced as a suitable traditional food for the diabetic patients.

4. CONCLUSION

De-fatted dehydrated coconut TF incorporation into WF for Sri Lankan traditional foods such as *roti* has considerable effect on physicochemical and sensory properties. The TF can be successfully incorporated to level of 20% to wheat flour to enhance nutritional qualities with acceptable sensory attributes.

5. REFERENCES

Akapata, M.I. & Akubor, P.I. (1999). Chemical composition and selected functional properties of sweet orange (*Citrus sinensis*) seed flour. *Plant Food Human Nutrition, 54*, 353–362.

AOAC International. (1999). Official methods of analysis of AOAC International, 17th Edition, Association of Analytical Communities, Gaithersburg.

APCC (Asian Pacific Coconut Community) (2020). APCC standards for virgin coconut oil. Asian and Pacific Coconut Community.

Appaiah, P., Sunil, L., Kumar, P. P. K. & Krishna, G. A. G. (2014). *Journal of American Oil Chemists' Society*, *91(6)*:914-926. https://doi.org/10.1007/sl 1746-014-2447-9.

Borla, O. P., Motta, E. L., Saiz, A. I. & Fritz, R. (2004). Quality parameters and baking performance of commercial gluten flours. *LWT- Food Science and Technology, 37*, 723–729. https://doi.org/10.1016/j.lwt.2004.02.013

Butt, M. S. & Batool, R. (2010). Nutritional and functional properties of some promising legumes proteins isolates. *Pakistan Journal of Nutrition, 9*(4), 373–379

Coultate, T. P. (2009). Food: The chemistry of its components. The Royal Society of Chemistry, Cambridge, UK

Cynthia, S. J., Bosco, J. D. & Bhol, S. (2015). Physical and structural properties of spray dried Tamarind (*Tamarind usindica* L.) pulp extract powder with encapsulating hydrocolloids, *International Journal of Food Properties*, *18*(8), 1793-1800. https://doi.org/10.1080/10942912.2014.940536

FPDD guide No.4, Rev 2 series (2019). Food Product Development Division, Albay Research Centre, Philippines Coconut Authority, Banao, Guinobatan, Albay, Phillipine

Gunarathne, K. M. R. U., Marikkar, J. M. N., Mendis, B. Yalegama, C., Jayasinghe, U. L. B., Liyanage, R. & Jayaweera, S. (2022). Bioactivity of different solvent extracts of partially defatted coconut testa obtained from selected coconut cultivars. Journal of Agricultural Sciences- Sri Lanka, 17(1):171-184.

Gunathilake, K. D. P. P., Yalegama, C. & Kumara, A. A. N. (2009). Use of coconut flour as a source of protein and dietary fibre in wheat bread. *Asian Journal of Food and Agro-Industry*, *2*(3), 382-391

Jayatissa, R. L. N., Wickranmasinghe, W. D. & Piyasena, C. (2014). Food consumption patterns in Sri Lanka. Hector Kobbekaduwa Agrarian Research and Training Institute.

Liyanage, Marasinghe, S. S. K., Nazrim, J. M., Marikkar, Yalegama, C., Wimalasiri, S., Seneviratne, G., Weerasooriya, R. & Liyanage,

R. (2019). Comparison of inter-varietal differences in chemical composition and nutritional properties of coconut testa flour. *Journal of the National Science Foundation of Sri Lanka, 47(3), 349-356*

Nasir, S., Allai, F. M., Gani, M., Ganaie, S., Gul, K., Jabeen, A. & Majeed, D. (2020). Physical, textural, rheological and sensory characteristics of amaranath-based wheat flour bread. *International Journal of Food Science, 2020, ID 8874872*http://doi.org/10.1155/2020/8874872.

Obert, J. C., Ridley, W. P., Schneider, R. W., Riordan, S. G., Nemeth, M. A., Trujillo, W. A., Breeze, M. L., Sorbet, R. & Astwood, J. D. (2004). The composition of grain and forage from glyphosate tolerant wheat MON 71800 is equivalent to that of conventional wheat (*Triticum aestivum* L.). *Journal of Agricultural Food Chemistry*, *52*, 1375–1384.

Okaka J. & Potter N. N. (1977). Functional and storage properties of cowpea-wheat flour blends in bread making. *Journal of Food Science, 42*, 828-833.

Oniszczuk, A., Widelska, G., Wójtowicz, A., Oniszczuk, T., Wojtunik-Kulesza, K., Dib, A. & Matwijczuk, A. (2019). Content of phenolic compounds and antioxidant activity of new gluten-free pasta with the addition of chestnut flour. *Molecules, 24*, 2623.

Perera, M. P. M. S. H., Sivakanesan, R., Abeysekara, D. T. D. J. & Sarananda, K. H. (2015). Glycemic response of traditional breakfast foods in adults with type 2 diabetes mellitus. *Tropical Agricultural Research, 27*(1), 39 – 48.

Ranasinghe, P., Jayawardena, R. & Katulanda, P. (2015). The facts, figures, and reality of the diabetes epidemic in Sri Lanka: a systematic review. *International Journal of Diabetes in Developing Countries, 35,501-513.* http://doi.org/10.1007/s13410-015-0326-z.

Rushdha, S. A. F., Uipathakumbura, B. S. K., Yalegama, C., Hewapathirana, D. T. & Marikkar, J. M. N. (2022). Evaluation of staple foods supplemented with defatted coconut testa flour. (Accepted for publication). *Cord, 38.*

Sami, W., Ansari, T., Butt, N. S. & Hamid, M. R. A. (2017). Effect of diet on type 2 diabetes mellitus: A review. *International Journal of Health Sciences, 11*(2),65-71.

Setia, R., Dai, Z., Nickerson, M. T., Sopiwnyk, E., Malcolmson, L. & Ai. Y. (2020). Properties and bread making performance of wheat flour composited with germinated pulse flour. *Cereal Chemistry*, *97*, 459-471.

Sri Lanka Standards Specification for coconut oil (2002). SLS 32:2002. Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 8, Sri Lanka.

Suresh, C., Samsher, S. & Durvesh, K. (2015). Functional properties of composite flour & sensorial attributes of composite flour biscuits. *Journal of Food Science & technology. 52(6)*,3681-3688.

Thathvasuthan, A., Chandrasekara, A. & Wijesinghe, D. G. N. G. (2007). The effect of type of cereal on the glycaemic response of two traditional Sri Lankan food items. *Tropical Agricultural Research, 19 (January*), 101–109.

Vissotto, F. Z., Jorge, L. C., Makita, G. T., Rodrigues, M. I. & Menegalli, F. C. (2010). Influence of the process parameters and sugar granulometry on cocoa beverage powder steam agglomeration. *Journal of Food Engineering*, *97*, 283–291.

World Health organization (2019). Retrieved on 12/03/2022 from Zmescience.com/ Science/who-report-fibres-14012019.