EXTENDED ABSTRACTS
of Research Presentations

Food Techno 2016
Innovation to Application

02nd Annual Research Session

INSTITUTE OF FOOD SCIENCE & TECHNOLOGY SRI LANKA (IFSTSL)

13th August 2016, *Mihilaka Medura,* BMICH, Colombo

Extended Abstracts of the Research Presentations

FoodTechno 2016

Second Annual Research Session of the IFSTSL

13th August 2016

Mihilaka Medura, BMICH Colombo, Sri Lanka

Organized by the Institute of Food Science & Technology Sri Lanka (IFSTSL)

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Second Annual Research Session of the IFSTSL - 2016

(13th August 2016 at Mihilaka Medura, BMICH Colombo, from 8.30 a.m. to 4.30 p.m.)

PROGRAM

8.30 – 9.00 a.m.	Registration of participants
9.00 – 9.05 a.m.	Traditional lighting of the oil lamp
9.05 – 9.15 a.m.	Welcome address by Dr. Eresha Mendis *President/ IFSTSL*
9.15 – 9.30 a.m.	Keynote speech: by Prof. Arthur Bamunuarachchi
9.30 – 10.00 a.m.	***TEA***

TECHNICAL SESSION I (*Session Chair: Emeritus Prof. Upali Samarajeewa*)

10.00 – 10.20 a.m.	COMPARATIVE STUDY OF ANTIMICROBIAL ACTIVITY OF SRI LANKAN GROWN GALANGAL AND GINGER AGAINST FOOD-BORNE PATHOGENS
10.20 – 10.40 a.m.	VARIATION OF YEAST, MOULD AND MOISTURE CONTENT IN BLACK TEA (*Camellia sinensis*) IN TIME OF STORAGE AT WAREHOUSE
10.40 – 11.00 a.m.	MODIFICATION OF PARBOILING PROCESS OF PADDY TO DEVELOP A RICE TYPE WITH RAW AND PARBOILED QUALITY CHARACTERISTICS
11.00 – 11.20 a.m.	STUDYING THE CAUSES OF UNWANTED GROWTH OF MICROBES IN VIRGINCOCONUT OIL
11.20 – 11.40 a.m.	UTILIZATION OF BANANA PSEUDO STEM EXTRACT FOR THE DEVELOPMENT OF A READY TO SERVE (RTS) DRINK
11.50 – 1.00 p.m.	***LUNCH***

TECHNICAL SESSION II (*Session Chair: Prof. Arthur Bamunuarachchi*)

1.00 – 1.20 p.m.	DEVELOPMENT OF A SAUCE USING *Gymnema sylvestre* LEAVES

1.20 – 1.40 p.m.	EFFECT OF *IN VITRO* DIGESTION ON THE ANTIOXIDANT PROPERTIES OF JACKFRUIT SEEDS AND ARILS
1.40 – 2.00 p.m.	CONSUMER BEHAVIOR AND AWARENESS ON PRE-WASHING CYCLES AND NUTRITIONAL VALUE OF RICE, IN IMBULPE DIVISIONAL COUNCIL AREA
2.00 – 2.20 p.m.	COMPARATIVE STUDY ON PHYSICOCHEMICAL PROPERTIES OF IMPORTED AND LOCALLY PRODUCED MILK POWDERS IN SRI LANKA
2.20 – 2.50 p.m.	***TEA***

TECHNICAL SESSION III (*Session Chair: Prof. K.K.D.S. Ranaweera)*

2.50 – 3.10 p.m.	EVALUATION OF ANTIOXIDANT ACTIVITIY AND CHEMICAL PROPERTES OF KOMBUCHA 'TEA FUNGUS' DURING EXTENDED PERIODS OF FERMENTATION
3.10 – 3.30 p.m.	EFFECT OF H_2O_2 IN REDUCING COLIFORM CONTAMINATION OF INGREDIENTS USED TO PREPARE UNROASTED CURRY POWDER
3.30 – 3.50 p.m.	DEVELOPMENT OF VEGANS CUPCAKES USING DURIAN SEED FLOUR; AN ATTEMPT TO REPLACE THE USE OF POULTRY EGGS
3.50 – 4.10 p.m.	ESTABLISHMENT OF PROCESSING PARAMETERS FOR THE DEVELOPMENT OF A SNACK FROM SWEET POTATO
4.10 – 4.20 p.m.	Award of certificates
4.20 – 4.30 p.m.	Vote of thanks by Dr. Niranjan Rajapakse/ Coordinator FoodTechno 2016

Message from the President of the IFSTSL

The second annual research session, FoodTechno 2016, organized by the Institute of Food Science and Technology, Sri Lanka (IFSTSL) is scheduled to be held on 13th August 2016, parallel to the Profood Propack exhibition at BMICH. The theme of this research session is "innovation to application", where IFSTSL expects to disseminate research knowledge acquired in universities, research institutes and other line agencies to the food industry seeking possible applications targeting innovation. The institute of food science and technology, in its mandate clearly identifies its service to the food sector specially aiming at the developments of the food industry in Sri Lanka. To accomplish this objective it requires connecting different stakeholder groups of the Sri Lankan food sector, specially the universities, research entities and the food industry in a common platform. This research session was started in 2015 with that prime objective and the positive comments received from the industry after the first session encouraged us to continue the event with improvements. The main positive change we did this time was deciding to hold the session parallel to ProfoodPropack exhibition, which is the largest food exhibition in Sri Lanka and where the food industrialists get -together to showcase their production capacities and capabilities to the public in Sri Lanka. So this is the best opportunity for the institute to meet the industry to develop a research dialogue which would benefit the food industry, and as a whole the food sector in Sri Lanka. As the president of the Institute of Food Science and Technology, I wish to extend my sincere thanks to Dr. Niranjan Rajapakse, the coordinator of this event and his committee for the untiring efforts to make this research session a great success. Further, I heartily congratulate the current Executive Committee of the IFSTSL for their dedication and commitment in IFSTSL activities and specially encouraging this very important event. I hope the participants will derive maximum benefit of this and I wish the IFSTSL annual research session 2016 every success.

Dr. Eresha Mendis
President of the IFSTSL

Message from the Coordinator of FoodTechno 2016

It is a great pleasure and a privilege for me to write this message on the occasion of the second annual research session 2016, organized by the Institute of Food Science and Technology, Sri Lanka (IFSTSL). In the mandate, IFSTSL has clearly identified its leading role in promoting the linkages among different stakeholder groups of the Sri Lankan food sector for scientific and technical support.

Research studies related to food science and technology are being conducted by several groups including universities, research institutes and other line agencies. The findings are disseminated among scientific communities mainly during research forums. Parallel to this, a line of publications are appearing in scientific research journals. Neither these research forums, nor the scientific publications effectively disseminate the knowledge ascertained by these researches to the food industry, where the highest need exists for knowledge to apply aiming at improvements or innovations in the food sector in Sri Lanka.

The main objective of this research session is to provide a common platform to cross interact between the universities conducting research related to food science and technology and the food industry. The food industry can gather the findings which are relevant to their scope, identify competent graduates to join with them and to highlight the research needs of the food industry having future prospects. I wish to thank the executive committee of IFSTSL, and the research presenters, who contributed enormously to make this research session a success. My thanks are also due to the sponsors and all the others who supported the activity. I wish this annual research session all success.

Dr. Niranjan Rajapakse
Coordinator/ FoodTechno 2016

Extended Abstracts of the Research Presentations

FoodTechno 2016- *Second Annual Research Session of the IFSTSL*

(13th August 2016 at Mihilaka Medura, BMICH Colombo, from 8.30 a.m. to 4.30 p.m.)

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COMPARATIVE STUDY OF ANTIMICROBIAL ACTIVITY OF SRI LANKAN GROWN GALANGAL AND GINGER AGAINST FOOD-BORNE PATHOGENS

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Summary

The antimicrobial activity of the crude ethanolic extract of galangal (*Alpinia galanga*) and ginger (*Zingiber officinale*) were tested against different strains of *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella Typhimurium* and *Escherichia coli* using disk diffusion and broth dilution assays. Galangal extract showed a significantly ($P < 0.05$) higher inhibition against *S. aureus* including Methicillin resistant *S. aureus* (34 mm) and *L. monocytogenes* (15.67 mm). The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of galangal extract against *S. aureus* were 1.25 mg/ml and 5 mg/ml respectively. Ginger extract showed significantly ($P < 0.05$) higher diameter of inhibition zone (DIZ) of 14.67 mm against *E. coli* compared to galangal extract. A minimum inhibition was recorded against *S. Typhimurium* for both galangal and ginger extract. The combined use of both galangal and ginger ethanolic extract may be effective as a natural preservative in food industry to combat food borne pathogens including *S. aureus* and *E. coli*.

Keywords: Galangal, Ginger, Ehanolic extract, Antimicrobial activity, Food-borne pathogens

Introduction

Food-borne pathogens have become a global crisis as the incidents of diseases due to food- borne pathogens have become a major problem throughout the world. It is reported that 30% of the population in industrialized countries are suffering from foodborne diseases each year (WHO, 2007). Microorganisms causing food spoilage has become one of the most important concerns in food industry. Many pathogenic microorganisms, such as *Escherichia coli*, *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus* have been reported as the causal agents of food-borne diseases (Böhme *et al.,* 2016). Therefore, it is important to combat these pathogens using antimicrobial agents. At present, there is a growing interest of using natural antibacterial compounds from extracts of herbs and spices for the preservation of foods due to consumer demand for natural ingredients in food. These extracts also possess characteristic flavors and odour which make the foodstuff more appealing to the consumers. *Alpinia galanga* (galangal) and *Zingiber officinale* (ginger) both belong to

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Family Zingiberaceae are known to possess antimicrobial activity against certain foodborne pathogens (Weerakkody *et al.*, 2011; Karuppiah and Rajaram, 2012).
The objectives of this study were to compare the antimicrobial activity of the ethanolic extract of galangal and ginger against common food-borne pathogen including *Escherichia coli, Staphylococcus aureus, Salmonella Typhimurium* and *Listeria monocytogenes*.

Methodology

Different plant parts of galangal were identified using a key (Dassanayake and Fosberg, 1983). Pieces of galangal and ginger rhizomes were dried at 40^{O}C in an oven for 3 days and subjected to ground to make a fine powder. Ethanol extracts were prepared by adding 10 g of powder of each rhizome to 100 ml of ethanol and agitating for 24 h at 28^{O}C in a rotary shaker. The content was vacuum filtered and concentrated under vacuum at 40^{O}C using a rotary evaporator followed by filter sterilization. The concentrated extract was evaporated to dryness by nitrogen fluxing and re-dissolved in Di methyl Sulphur Oxide (DMSO) to make a 0.5 g/ml stock solution and stored at 4^{o}C until use. The antimicrobial activities of the extracts were evaluated using a slightly modified agar disc diffusion method (Barry, 1976). Microbial inhibition was determined by measuring the diameter of the clear zone of inhibition of growth around each disc and recorded as diameter of inhibition zone (DIZ) in millimeter. The best performed extract from disk diffusion assay for most susceptible microorganism was further evaluated for antimicrobial activity using minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) using broth dilution assay (Hufford and Clark, 1988). Data were expressed as mean± standard deviation of triplicates. The results from disk diffusion assay for both extracts were statistically analyzed using ANOVA of the General Linear Model of SPSS statistical package (Version 16) at 5% significance level. Means were compared using Tukey's simultaneous test procedure at $p< 0.05$.

Results and Discussion

Different plant parts used for identification of the *A. galanga*, is shown in Fig. 1.

(A) **(B)** **(C)** **(D)**

Fig.1. Characteristic features of different plant parts of *Alpinia galanga* grown in Sri Lanka (A) Flower, (B) Inflorescence, (C) Capsule and (D) Shrub

The DIZ measured in disk diffusion assay are presented in Table 1. Galangal extract showed significantly ($P < 0.05$) higher DIZ ranging from 33 mm to 34 mm against tested strains of *S. aureus* and 15.67 mm against *L. monocytogenes* compared to ginger. However, ginger extract showed antimicrobial activity against *E. coli* with significantly ($P < 0.05$) higher DIZ of 14.67 mm compared to galangal extract. A minimum inhibition zone was recorded against *S. typhimurium* for both galangal and ginger extract.

Table 1: Antibacterial activity of galangal and ginger ethanolic crude extracts against different strains of food-borne pathogens using disk diffusion assay.

Food-borne pathogen	**Zone of growth inhibition/DIZ (mm)***	
	Galangal	**Ginger**
Staphylococcus aureus 49476	33.33 ± 1.15^{a}	14.33 ± 0.58^{bcd}
Staphylococcus aureus 113	34.00 ± 0.00^{a}	13.67 ± 0.58^{bcd}
Salmonella Typhimurium	7.67 ± 1.15^{e}	8.00 ± 0.00^{e}
Listeria monocytogenes Scot A	15.67 ± 1.15^{b}	12.33 ± 1.53^{cd}
Listeria monocytogenes V7	15.33 ± 0.58^{b}	12.00 ± 1.00^{d}
Escherichia coli	6.34 ± 0.58^{e}	14.67 ± 0.58^{bc}

* The mean values followed by the same lowercase letter are not significantly different at $P < 0.05$ level.

The MIC for galangal extract against tested strains of *S. aureus* showed 1.25 mg/ml at 24 h. The MIC values did not change at 48 h. The minimum bactericidal concentration for both tested strains of *S. aureus* was found to be 5 mg/ml and the value did not change at 48 h.

The results in this study indicated that both extracts of spices have antibacterial activity with variable degree of sensitivity towards tested bacterial species. According to DIZ values, *E. coli* was more susceptible to ginger extract than galangal while *S. aureus* and *L. monocytogenes* were more susceptible to galangal extract than ginger. The DIZ demonstrated that both extracts were not effective on *S. Typhimurium*. However, crude ethanolic extract of galangal showed a good activity against *S. aureus* including methicillin resistant *S. aureus* (Fig. 2). The results of our study corroborate with the published data from previous studies for ethanolic extract of galangal against *S. aureus* (Oonmetta-aree et al. 2006) and ethanolic extract of ginger against *E. coli* (Gull et al., 2012; Karuppiah and Rajaram, 2012). In particularly, it was interesting to note that Gram-positive bacteria (*S. aureus* and *L. monocytogenes*) are more sensitive to galangal extract than ginger extract while Gram-negative bacteria such as *E. coli* are more sensitive to ginger extract.

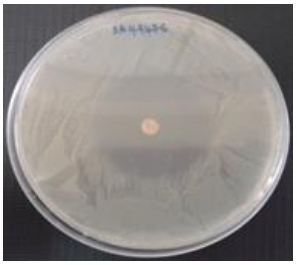

Fig. 2. Diameter of inhibition zone for galangal ethanolic extract against *Staphylococcus aureus* 113

The major chemical compound responsible for the antimicrobial activity of a plant extract is important for further investigations. It is reported that sesquiterpenoids are the main component of ginger which attributes its antibacterial activity (Malu *et al*., 2009). In contrast, the major chemical compound for ethanolic extract of Thailand grown galangal was reported as 1' acetoxychavicol acetate (1'ACA) (Oonmetta-aree *et al*., 2006) and 1'ACA has been shown to possess antimicrobial activity against *S. aureus*, *Staphylococcus epidermidis*, *Propionibacterium acnes* and *Vibrio parahaemolyticus* (Niyomkam *et al*., 2010 ; Vuddhakul *et al*., 2007). Plant derived antimicrobials can be used as food preservative to control natural spoilage processes and to prevent or control growth of pathogenic microorganisms to assure food safety.

Conclusion

The combined use of both galangal and ginger ethanolic extract may be effective as a natural preservative in food industry to combat food-borne pathogenic *S. aureus*, and *E. coli*. Further studies are needed to evaluate the synergistic antimicrobial activity of both Galangal and Ginger extract on a given food product.

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VARIATION OF YEAST, MOULD AND MOISTURE CONTENT IN BLACK TEA (*Camellia sinensis*) IN TIME OF STORAGE AT WAREHOUSE

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Summary

Tea (*Camellia sinensis*) is the most popular and cheapest beverage, next to water, in the world. Processed made tea is prone to moisture content variation and microbial contamination during handling and prolonged storage at warehouse. Yeast and mould are detrimental in tea due its low moisture content compare to other harmful microorganisms. The aim of this study was to investigate the variation in moisture content, yeast and mould variation in tea during storage. Samples were stored in multilayer bags at temperature 30°C and 70% relative humidity for 1, 2, 3, and 4 months. Moisture content, yeast and mould were analyzed. Continuous increase in moisture content, yeast and mould were observed with stored samples. Storage time have a significant ($P<0.05$) effect on moisture content. The results showed that the maximum moisture content of tea samples was 4.99 % after 4 months storage, which is 0.74 % more than the initial moisture content. However, observed moisture content and yeast and mould count were below the Sri Lanka Tea Board limits 9% and 1000 cfu/g respectively.

Keywords: Tea, Moisture content, Yeast and mould, Storage of tea

Introduction

Tea (*Camellia sinensis*) is one of the most widely consumed beverages in the world today and its health effects have been widely studied (Namiki, 1990). Sri Lanka is the major tea exporter in the world market. Quality of black tea is the cumulative effect of all desirable attributes by which it is judged for its market value. Primary processing of tea involves a number of steps, at the end of which the tea leaves are heated to a temperature of approximately 80^{o}C. This temperature is sufficient to reduce the high bacterial and fungal load. However, because of improper storage, handling, and packing after drying, microbial contamination of the processed tea leaves can occur (Wilson *et al.*, 2004). Tea stays freshest when stored in a dry, cool, dark place in an air tight packaging material. In this study, variation of moisture content and yeast and mould with storage time was investigated.

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Methodology

Samples were stored in multilayer bags at temperature 30°C and 45 % relative humidity for 1, 2, 3, and 4 months. Sampling was accomplished monthly during this period. Moisture content, yeast and mould were investigated at the beginning of trial and during storage period.

The moisture content was determined on wet weight basis (ISO 1573: 1980). Yeast and mould count (YMC) were determined using the standard pour plate method (ISO 21527: 2008). Proc mixed analysis of variance using SAS® (2002, version 9.13; SAS Inst., Cary, N.C., U.S.A) was done to analyse the moisture content of tea in storage at significant level of 0.05. The nonparametric test was used to analyze the data of yeast and mould in MINITAB® (2010, version 16, Microsoft, U.S.A) at significant level 0.05.

Results and Discussion

Table 1 showed the changes of moisture content, yeast and mould during storage time during the storage time. It was observed that moisture content, yeast and mould increases with storage time. Moisture content of 0, 1, 2, 4 and 4 months stored tea samples were 4.25, 4.49, 4.6, 4.9 and 4.99 % respectively. Mean yeast and mould counts are 248, 455, 707, 748, and 780 cfu/g in the samples stored for 0, 1, 2, 3 and 4 months respectively. Storage time had a significant effect ($P<0.05$) on moisture content, yeast and mould variation. Yeast and mould count increased with moisture content as shown in figure 1.

Table 1. Changes of moisture content, yeast and mould with storage time.

Storage time (months)	Moisture content (%)	Yeast and mould (cfu/g)
0	4.25±0.39	248
1	4.49±0.68	455
2	4.60±0.49	707
3	4.90±0.18	748
4	4.99±0.68	780

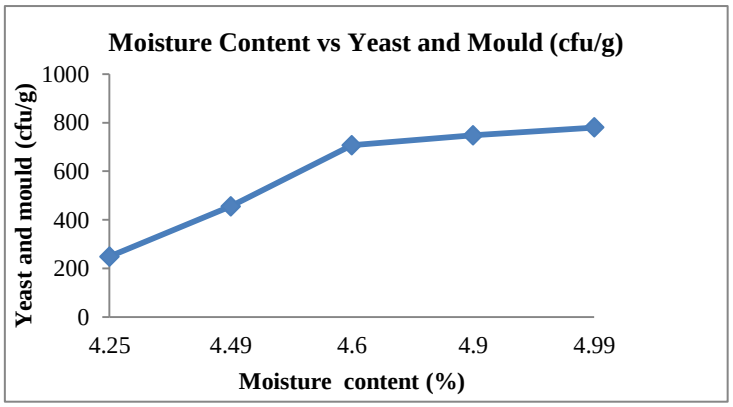

Figure 1. Changes of yeast and mould with moisture content (%)

The results show that the maximum moisture content of tea samples was 4.99% after 4 months storage, which is 0.74% more than the initial moisture content. The acceptable level of moisture in packed tea is 9% based on Sri Lanka Tea Board standards. Packaging material maintains constant moisture content during storage, so moisture content in tea is an essential parameter of quality. High moisture content can have negative effect on shelf life of the product, so for the better quality of the product moisture percentage should be controlled between 2.5- 6.5% (Yao *et al.,* 2006).

All tested samples were contaminated with yeast and mould but the microbial load is below 1000 cfu/g. If the storage conditions changed and the moisture of the product increased, they could proliferate and spoil the product and possibly produce mycotoxins. Higher yeast populations could be the result of non-strict GMP and hygienic conditions during preparation and packing of the product.

Temperature is controlled to avoid major variations in room temperature because large differences of temperature between air and the product result in condensation and a source of microbial contamination. High humidity is detrimental in many respects such as accelerating the growth of bacteria and mould, promoting insect infestation and causing mustiness in tea. The desirable relative humidity is between 40-50%. Growth of mould becomes a serious problem if the humidity of the warehouse is higher than 55 %.

Conclusions

Storage time have a significant ($P<0.05$) effect on moisture content. Moisture content, yeast and mould increase with storage time. Moisture content and yeast and mould count were below the Srilanka Tea Board limit 9% and 1000 cfu/g respectively.

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MODIFICATION OF PARBOILING PROCESS OF PADDY TO DEVELOP A RICE TYPE WITH RAW AND PARBOILED QUALITY CHARACTERISTICS

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Summary

The objective of this research was to develop a hybrid rice type which has both parboiled and raw rice characteristics. In both long and short grain varieties of paddy, (BG 352 and BG 358, respectively) the water uptake during hot soaking (70ºC) under vacuum treatment (42.93% and 40.22 %, respectively) were significantly ($P<0.05$) higher than that of non-vacuum conditions (31.95% and 31.83% respectively), after 2h of soaking, exhibiting the effectiveness of water diffusion into the rice grains through the cleared pores under negative pressure treatment. This finding was further confirmed by X-Ray Fluorescence (XRF) images using zinc ions which represented the diffusion path of water in the pore structure of the rice kernel. The backlit photographs of rice on a scanner showed that after the treatment, the inner layers of the rice kernel remained raw while having a transparent and hard outer layer, as a result of partial gelatinization. The data obtained from this study can be used by rice processors in order to save energy in white bellied rice production as well as to produce a uniform hybrid rice type which can be introduced to all raw and parboiled rice consumers

Keywords: Parboiling, Gelatinization, Raw rice, Soaking, Vacuum

Introduction

Parboiled rice has low head rice loss during milling and higher resistance to pest damages. Despite the 40% market share in Sri Lanka, some consumers do not like the color and taste of parboiled rice. Therefore the objective of this research was to develop a rice with, both parboiled and raw characteristics. Such partially gelatinized rice products available, have a huge variation in quality due to different process parameters. Usual practice is cold soaking of paddy for 8-16h followed by 5-20 minutes steaming. The resultant product is called white bellied rice ("*Bada bath*" in Sinhala), a product with a high demand in Sri Lanka. With this study, the optimum conditions to make white bellied rice has been identified, promoting it as a hybridized rice type which has a hard crust around the rice kernel which makes rice more resistant to pest damages and breakage on milling and a raw core which is preferable to consumers.

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Methodology

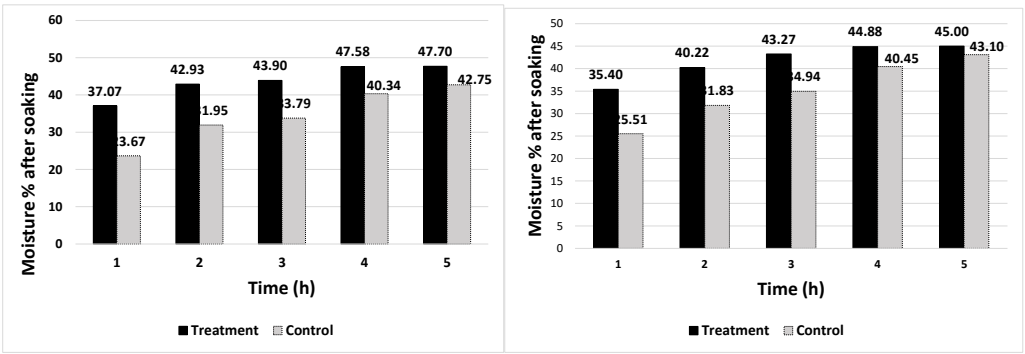
The water absorption characteristics of paddy was determined by taking 20 g of paddy samples with 13% moisture level (Nordic Scientific GMK 303, Sweeden) of each cultivar (BG 352 and BG 358, CIC Agri Business, Kandy) and placing in water beakers separately in a hot water bath ($60^{O}C$). For the treatment samples, 1h vacuum condition (-0.6 bar) was given in 1st soaking hour and the rest of 4h, paddy samples were soaked in atmospheric pressure. The control samples from both paddy varieties were given the similar conditions except the initial vacuum condition. Instead they were soaked in the atmospheric pressure in total 5h of soaking. The samples were removed at predetermined time intervals of 1h up to 5h.The final weight of paddy was taken (AG204DR, Mettler Toledo, Switzerland) after surface water was removed. All the samples were triplicated. The results were analyzed by Repeated Measure Analysis of Variance (RMANOVA), and Duncan's multiple range test by Statistical Analysis System (SAS). The moisture % was calculated by the following equation.

Moisture % = {(Final weight-Dry weight)}/ Dry weight) × 100

Pre cleaned, dried paddy samples (BG 358) were placed in glass beakers and 400ppm zinc sulphate solution ($ZnSO_4$. $7H_2O$(S) Loba Chemie Pvt Ltd, India) was added into each beaker maintaining the grain to liquid ratio of 1:1.5 (V/V). Treatment samples were vacuumed (-0.6 bar) for 1h and then pressure was increased to atmospheric pressure during hot soaking ($60^{O}C$) for another 1h. Control samples were also given similar conditions except the duration of soaking which was continued for 5h. The soaked paddy samples were steamed for 20 minutes (100oC) while checking by a thermometer (DTM 316, Tecpel, Taiwan). After that the paddy samples were sun dried to 13% moisture level and de-husked by the rice milling machine (THU 35 A, Satake Engineering Co., LTD, Japan). The cross sectional views of rice samples were analyzed by X-Ray fluorescence (XRF) imaging (Horiba X-5000, USA) and surface views were observed with the help of a lightened surface of a scanner.

Results and Discussion

Both rice varieties in the treatment samples absorb water at a significantly ($P<0.05$) high rate than control samples every hour (Duncan's multiple test). Water content of short and long grain paddy at several time intervals are shown in figure1. Both samples indicate rapid water diffusion during the first hour. Figure 3 shows the backlit images of rice grains after different process conditions. Figure 2, (a) indicates that all the rice grains have a similar pattern of gelatinization towards the outer most layers of the endosperm while keeping the core un-gelatinized. Figure 2 (c) shows that there is a variation among rice kernels obtained from a market available white belly rice.

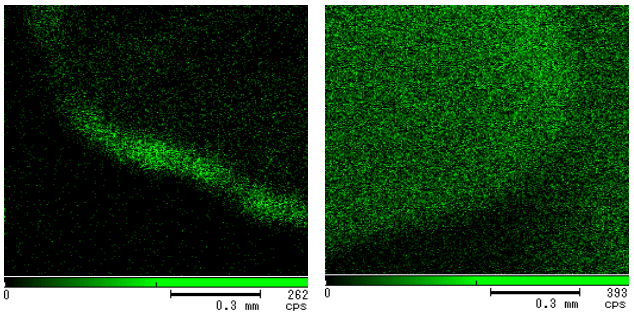


(a) **(b)**

Figure 1: Moisture % after soaking in treatment and control paddy samples; (a) BG 352, (b) BG358

(a) **(b)** **(c)**

Figure 2: Backlit images of rice grains on a scanner; (a) Newly produced hybrid rice, (b) Fully parboiled rice, (c) White bellied rice from the market



(a) (b

Figure 3: Distribution of Zn ions in the rice endosperm; (a) after 2h , (b) after 5h of soaking

Figure 3, (a) and (b) show the XRF images of Zn distribution of in the rice kernel after 2h of soaking and 5h of soaking respectively. Zn was used here as an indicator for water absorption.

Water diffusion pathway starts from the void between hull and the grain towards the porous starch structure of the grain. This phenomenon happens due to molecular attraction and hydration. The rapid diffusion of water in the 1st hour is due to the capillary inhibition of the pericarp. Secondary reason to this rapid increase is filling of water into the void between hull and the kernel (Renfu, 1994). Figure 2, (a) shows that after 2 hours of soaking, water filled into the void has further diffused into the grain reaching a plateau making a thin hard layer around the rice kernel, after gelatinization

and sun drying leaving a raw core inside. When fully diffused paddy being parboiled after 5h of soaking, resultant product is a totally gelatinized rice grain with no remained white belly (Figure2, b). The kernel to kernel variability of gelatinization is shown in figure 2, (c) in a market available white bellied rice product. Newly produced rice kernels are similar to each other compared to the normal white bellied rice from the market. In normal white bellied rice production, the long durations of soaking with a large amount of water and paddy, cause the paddy in the bottom layer of the tank tend to absorb more water due to high pressure and undergo complete gelatinization once steamed, while the paddy in top layers, become partially gelatinized due to low amount of water absorption. But with the proposed method, the duration of soaking has been reduced to 2h, thus preventing the product variation maintaining uniformity among all the rice kernels. After 2h of soaking, Zn has penetrated into the rice kernel, making a thin layer of Zn, around the endosperm as seen in figure3, (a). After 5h of soaking Zn ions has made their way towards the inner most layers of the endosperm covering the whole rice kernel. This is how water has penetrated into rice kernels, with different soaking durations, under the proposed method.

It was identified from figure 1, after 2h of soaking, both long and short grain varieties of paddy have significantly higher ($P<0.05$) water uptake with the vacuum treatment (42.93% and 40.22%, respectively) than that of non-vacuum conditions (31.95% and 31.83% respectively). Figure 2 and 3 confirmed that the rice grains have achieved expected qualities of white bellied rice after 2h of soaking.

Conclusions

Hot soaking of paddy in a vacuumed chamber, significantly increases the diffusion of water and water dissolved ions in to the grains irrespective of the grain size by the capillary movement. It is sufficient to have a thin layer of gelatinized starch around the rice grain to reduce head rice loss during milling and pest damages during storage. The newly produced, partially gelatinized rice has absorbed enough water to obtain a hard covering within 2h, under the conditions given during soaking. The resultant rice has a raw core, pleasant odor, more whitish color when compared to the traditional parboiled rice and more uniformity than market available white bellied rice. This rice can be produced within 2h of soaking at $60^{O}C$, under -0.6 bar and atmospheric pressure followed by 20 minutes of steaming in $100^{O}C$, keeping other drying and milling practices the same. This method saves energy in white bellied rice production as well as produces a uniform rice type which can be introduced to all raw and parboiled rice consumers

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STUDYING THE CAUSES OF UNWANTED GROWTH OF MICROBES IN VIRGINCOCONUT OIL

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Summary

Virgin coconut oil (VCO), extracted from fresh coconut meat without chemical processes is said to be totally organic product. Since it starts from fresh coconut, and not from commercial "copra" chemicals and bleaching clays for filtering and the deodorization process are not practiced during the production of the virgin coconut oil. The world market of VCO is now facing a problem with increasing yeast and mold count in processed VCO especially under storage. So the objectives of this study were to determine the deviation of chemical properties of contaminated VCO with standard values, identify the grown yeast and mold in contaminated VCO samples and their growing conditions, identify the critical point of contamination throughout the process line, and finally to suggest control measure for eliminate particular microbial contamination. Samples from soon after processing, stored VCO samples with and without contamination were selected and determined the yeast and mold count, then chemical parameters such as acid value, peroxide value, and iodine value. Then particular fungal strain was isolated using PDA & SDA media and then morphologically identified depending on conidiophores structures that to be *Aspergillus* spp. As the critical point of contamination, filtration step was identified and maintaining hygiene in filtration area should be done in order to eliminate this problem. Clean the filter cloth after each and every batch of VCO, using ventilation system, sanitation methods would be helpful to reduce the total yeast and mold count of VCO. Being an organic product preventing is the best solution for this condition rather than doing physical and chemical treatments.

Keywords: Virgin coconut oil (VCO), *Aspergillus* spp.

Introduction

According to the recent product specification of HJS Company Ltd, the VCO will be last for two years with its best product qualities, and not being non suitable for human consumption. But the management has observed some mild development of fungus at the bottom of some bottles after one to two months of storage. It was observed that the condition is going to be accelerated under low temperature storing conditions. This causes to reduce the quality of the end product as well as the shelf life which eventually

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affects the profit and the good name of the company. Thus, finding the causes for this problem and a solution is an immensely important.

Methodology

Samples of VCO soon after processing and stored VCO samples with and without microbial colonies were used to isolate the responsible microbes for the contamination. Apart from that, VCO samples were taken from various stages to determine the critical points of contamination.

The moisture content of the VCO samples was determined with using IR moisture analyzer (Thermograv, MA35M-000230V1,China). Water activities of the VCO samples were measured using the water activity meter (Ohaus, MB 35, China). Acid value of VOC was determined following the method of Kardash and Tur'yan, 2005. Peroxide value was determined according to the method of Takagi *et al.* (1978). Iodine value was obtained following the method of Pocklington (1990).

In order to get the yeast and mold count SDA and PDA media were used. MRD media was used to prepare the stock solution and the dilution series. For the isolation of the fungal strains the oil at the upper part of the contaminated oil bottle was removed as much as possible. The rest with fungal growth was mixed well using a vortex mixture. Fifty micro liters from each sample were added into the previously prepared PDA media and spreaded uniformly. Petri dishes were incubated at 30°C for three days. Colonies with different sizes and colors were streaked separately and this was repeated until a uniform appearance obtained. Isolated fungal strain was morphologically identified by using the microscope. Slides of the isolated strains were prepared as follows. After placing a drop of 10% KOH solution, a small amount of fungal culture removed from the edge of young colonies was spreaded using a sterile needle in order to tease out the fungal structure. The cover slip was gently placed on the slide by lowering it down in a way to avoid formation of air bubbles. The structure of the fungal spores was observed under the microscope.

Results and Discussion

As shown in the figure 1 all samples show comparatively high percentage of moisture in the bottom layer than middle and surface layers, with irrespective whether they are contaminated or not. High content of moisture increases hydrolysis, which leads to a higher free fatty acid content and hydrolytic rancidity.

According to the figure 2, in non-contaminated samples, the free water or the water activity of the bottom layers are relatively higher than that of the middle and surface layers. But when consider the contaminated samples, the water activity of the bottom layers have been decreased than that of middle and surface layers. Freshly-produced VCO contains small amounts of water naturally emulsified in the oil. The amount of water depends upon the processing methods. Greek researchers (Koidis, *et al*., 2007) examined freshly produced (cloudy) VCO and commercially filtered VCO, and found that the water content ranging from 0.17 to 0.49% for the cloudy oils and 0.08 and 0.09% for the commercial oils. Microorganisms were trapped in the water droplets in the cloudy oils. The size of the water droplets was 1 to 5 µm in the freshly produced oil

and after one month of sedimentation, a sample from the bottom portion of the oil showed a higher concentration of droplets, but the droplets remained approximately the same size. The small size of these droplets limits nutrient availability and "space" for microorganisms (Dimzon *et al*., 2011). When microorganisms grow by consuming this "space", remaining free water amount would be decreased. So as described by Dimzon *et al*. (2011), the low water activity level of bottom layer of the contaminated samples could be due to the growth of the fungal strains.

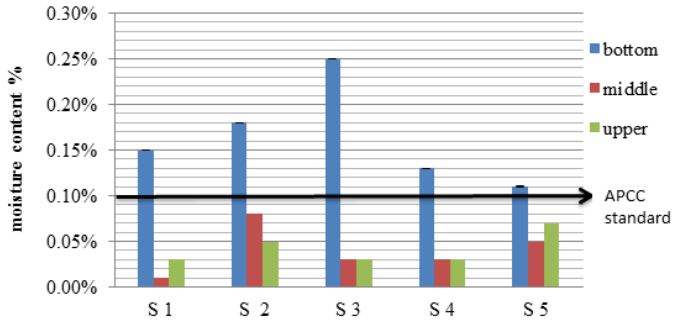

Figure 1 Moisture percentages of different layers of contaminated & non-contaminated VCO samples. Values of each bar represent the average of three replicates.

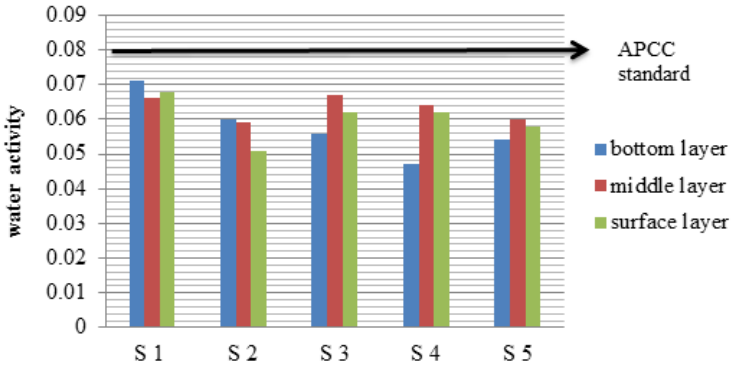

Figure 2 Water activities of different layers of VCO samples. Values of each bar represent the average of three replicates.

The maximum standard acid value of VCO is 0.2 mg/ one gram of oil (Pearson, 973). Contaminated samples (S3, S4, and S5) are having higher acid value when comparing with standard values while that of non-contaminated samples (S1 and S2) are having closer to the standard levels. It shows that the contaminated VCO samples show rancidity characteristics. It was revealed that, oil taken after the extraction process contains more free fatty acids, and it reduced values to closer to the reference value during settling and filtering. Free water that has been already immersed in oil plays an important role in this step. But while settling completed most of those immersed moisture could be removed, and due to that the influence towards acid value decrease (Dimzon *et al*., 2011).

The contaminated VCO samples (S3, S4 and S5) gave a higher peroxide value than standard value (4.5, 4.2, and 3.9 meq/kg respectively). The low average peroxide value

of sample 1 and 2 (2.5 and 2.0 meq/kg respectively) indicate that those non-contaminated VCO samples do not undergo significant peroxidation during processing or storage.

Figure 3 shows the way of Iodine value fluctuation in each VCO sample. This test involves the addition of iodine to double bonds. Both contaminated (S3, S4, and S5) and non-contaminated VCO samples (S1 and S2) also have higher iodine value in between APCC standard values. When there are double bonds in fatty acids it becomes more susceptible for the oxidative rancidity (Mughal *et al*., 2012). The contaminated VCO samples are already under gone with the oxidative rancidity. Due to that they also do not carry more unsaturation fatty acids and have normal iodine value just like normal VCO.

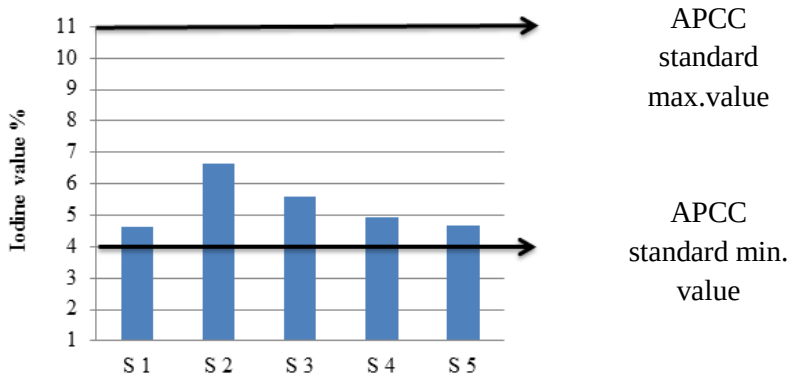

Figure 3 Comparison of iodine values of contaminated and non-contaminated VCO samples. Values of each bar represent the average of three replicates

The yeast and mold counts of non-contaminated samples (S1 and S2) were also found to be higher than both standard levels. But, when compared to the yeast and mold counts of the contaminated samples (S3, S4 and S5), that of non-contaminated samples were found to be very much closer to the manufacturer's standard (<100 cfu/g), which resembles that they are in good quality. Out of contaminated samples, sample no 3 was purposely selected for the further microbial tests because it showed comparatively higher yeast and mold count than the other two contaminated samples (S4 and S5). With using above isolates, morphological identification was done by methylene blue method (Conner and Beuchat, 1984). Depending on the morphology of the conidiophores and conidia it was identified as to be *Aspergillus* spp.

The process line was observed to identify the critical points of contamination and samples were collected from major steps as, after extraction, after settling and after filtering. Yeast and mold count of each sample was enumerated, and compared with the initial count of standard VCO sample. The yeast and mold count had been drastically increased after filtration step. Filtration is the final step done immediately before packaging. If VCO samples contaminate with microbial spores in this step, they can be further grow when they receive a favorable condition in the VCO bottles. *Aspergillusis* an air born mold. So filter cloth can be contaminated by its spores easily, and filtered oil could be easily contaminated.

Conclusion

At the bottom of each sample, moisture has been accumulated by sedimentation with time. In contaminated VCO, free water that accumulated at the bottom due to the density difference, have been utilized for fungal growth. In contaminated samples rancidity has been developed due to hydrolysis and fungal invasion. Contaminated VCO samples are no longer suitable for consumption due to rancidity. According to the morphological characters, the growing fungus is *Aspergillus,* and the contamination is happening at the filtration step. The variation in the frequency of their occurrence reflects differences in the inoculum density in the prevailing environmental conditions favoring the growth of the fungi. It can be concluded that *Aspergillus* species can grow and metabolize food under favorable moisture and temperature conditions causing spoilage or bio deterioration of the affected products.

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UTILIZATION OF BANANA PSEUDO STEM EXTRACT FOR THE DEVELOPMENT OF A READY TO SERVE (RTS) DRINK

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Summary

A variety of soft drinks are available in the market. Majority of them belong to carbonated beverages. People are willing to accept fruit juice based beverages other than to the carbonated soft drinks. Because, fruit juice based beverages have obvious advantages including higher nutritional value over the synthetic aerated beverages. Development of RTS based on banana pseudo stem is beneficial. Because banana pseudo stem is edible and having several health benefits according to the system of endogenous medicine .Most of time after harvesting banana, remaining parts are discarded. It will cause environmental impacts. Development of this kind beverage would reduce these kinds of problems. Because banana is widely grown all over the country and raw material availability is easy to initiate manufacturing of beverage. This beverage would be a beneficial for farmers who are doing cultivation of banana. They would have an extra income because development of RTS is cost effective.

Keywords: Soft drinks, Carbonated beverage, Banana pseudo stem, Aerated beverages, Banana, RTS

Introduction

Banana (*Musa cavendish*) is one of most abundant fruit crop in Sri Lanka. Approximately 100,000 farmers are engaged to cultivate banana in Sri Lanka (DOA, 2006). After harvesting, a huge amount of biomass is discarded without further utilization. That contains sheaths, pseudo stems and underground stems (corms). This waste may influence environmental problems. Pseudo stem seems to be a rich source of fiber. According to the reported data, moisture, total sugar, protein, lipid, sodium, potassium and calcium contents are 90%, 0.014%, 0.005%, 88mg/l, 874mg/l, 130mg/l respectively (Ferrotti & Guti, 2009). Sri Lankan indigenous medicine uses pseudo stem juice to treat urinary disorders, to remove stones in kidneys, stomach problems such as constipation, diarrhea and also diabetes and intestinal worms. At present negligible amount of banana pseudo stem is used for human consumption. Therefore development of RTS by utilizing pseudo stem extraction is beneficial. This beverage can be consumed as a sports drink (isotonic drink). Because pseudo stem extraction is rich in sodium, potassium, calcium and other minerals (Ferrotti & Guti, 2009. However, no research has been done to develop any commercially viable food product by using banana pseudo stem in Sri Lanka. Therefore, this study would be beneficial for the

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small scale and large scale beverage processors in developing such products to the Sri Lankan market.

Methodology

Remove the outer most sheaths and take the inner core. It was washed by portable water and cut into small cubes. Four methods were followed for recovering of browning formation. In commercially available lime juice treatment, Small cubes of pseudo stem inner cores were dipped into 1% lime juice solution. Cubes were chopped and blend with lime juice. Extraction was taken. In hot water treatment with citric acid, small cubes of pseudo stem inner core were dipped into hot water (temperature 70ºC). Then it was blended with hot water and citric acid. In citric acid treatment method, Pseudo stem cubes were dipped into 1% citric acid solution. Then they were chopped and blended. And extract was taken. A pH series was prepared with different amount of citric acid. In the ascorbic acid treatment, Pseudo stem cubes were dipped into 1% ascorbic acid solution. Then they were chopped and blended. Extraction was taken. A pH series was prepared with different amount of ascorbic acid. When preparation of passion fruit extract passion fruit was taken and it was washed. It was cut into two parts. Extraction was filtered and juice was taken. Extraction was taken after filtering pulp of pseudo stem. Passion fruit extraction was taken as a flavoring substance. Pseudo stem extraction was mixed with 7:1 proportion. Brix, pH and acidity were maintained according to the SLS standard (729:2010). Hot filling was done into glass bottles. Sensory quality was evaluated for prepared two samples. 30 untrained panelists were used to gather the data. Parameters such as appearance, colour, taste, sweetness, aroma and astringency were considered. Data was evaluated using SAS 9.3 seven point hedonic scale. Acidity, total soluble solids pH and acidity were evaluated. Proximate analysis was done for ash and fiber. Shelf life of the product was analyzed for two weeks under ambient temperatures and refrigeration condition.

Results and Discussion

For the pH series preparation five sample (A,B,C,D) were prepared with control sample.0.3%, 0.25%, 0.2%, 0.1% citric acid amount were used. pH of the hot water and citric acid treatment method, pH values were recorded as 3.04, 3.17, 3.34, 3.70 respectively. For the control sample pH value is 5.90. In citric acid treatment method pH value recorded as, in order to 2.99, 3.08, 3.20, 3.39, 4.95 for above mentioned citric acid amounts. In the ascorbic acid treatment method pH value recorded as 5.95 for 0.08% ascorbic acid concentration. Among the sensory attributes tested it was found that there were no significant difference between the samples for a sweetness ($p=0.7147$) and astringency ($p=0.2632$) sourness ($p=0.8037$). Whereas, there were significant difference among samples for appearance ($p<0.001$), colour ($p<0.001$), aroma ($p=0.001$). Hence, overall acceptability for two samples were ($p= 0.0644$) at 5% level of significance. For the final sample total soluble solids15.3° Brix, pH 3.97, acidity 0.9% were observed. Ash content was observed as 0.18% and fiber content was observed as 1.98%.after two weeks bacterial count was 5.59×10^4 cfu/ml.

Just after harvesting, raw material is highly vulnerable for browning. Prevention of browning formation was difficult effort. Commercially available lime juice and hot water treatment is not sufficient for prevention of browning. Application of citric acid is successfully prevented of browning formation.0.3% and 0.1% is maximum and minimum concentration which are used in pH series. In order to 2.99 and 3.29 pH was recorded for this acetic acid concentration. PH is too less. After, citric acid concentration was reduced up to 0.08%. But high acidic taste was observed. Therefore, usage of citric acid was avoided. As an another option, ascorbic acid was used. Because which can bedegraded during the heat treatment.0.1% of ascorbic acid was used. PH acid was recorded as 4.92.Ascorbic acid amount was reduced further up to 0.08% and browning was completely avoided. PH was recorded as 5.95.Hence this citric acid amount was used for preparation of RTS. Banana pseudo extraction is not tasty total soluble solid recorded as 2.4 and pH is 6.02. To enhance the flavour of final product natural flavours added. One sample was prepared without adding flavouring for other sample passion fruit extract was used to enhance the organoleptic properties of the final product. For the prevention of sedimentation pectin and carboxy methyl cellulose (CMC) were used. Pectin was not sufficient for the prevention of sedimentation. Because of pseudo stem contents calcium ions. Therefore calcium ions can precipitate as calcium pectate. Therefore CMC was taken as suitable stabilizer

Conclusion

Prepared pseudo stem pulp is suitable to store under refrigeration condition for 20 days without changing it's properties. Both of acetic acid and ascorbic acid are suitable for prevention the formation of browning. Utilization of ascorbic acid is applicable for preparation of ready to serve drink because which can degrade during the heat treatment otherwise high acidic taste may form for the final sample. According to the sensory test there was no significance difference between the two sample. 15.3^{O}Brix, 3.97ph and 0.9% acidity were recorded for the passion fruit flavored sample. Shelf life of the product should be analyzed by periodic microbial analyses under ambient temperatures and refrigeration condition. Preparation of passion fruit flavored pseudo stem RTS is cost effective. As a production cost around Rs 18/= for 180 ml passion fruit flavored banana pseudo stem RTS.

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DEVELOPMENT OF A SAUCE USING *Gymnema sylvestre* LEAVES

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Summary

The consumption of functional foods has become more popular in the recent past. In current years there is a great demand for medicinal plants. *Gymnema sylvestre* (GS) is one of the medicinal plants. Development of sauce from (GS) leaves is an effective way to supply the health benefit. The research was conducted in three stages. In the first stage, select the best (GS) leaf extract concentration (LEC) and in second stage, select the appropriate thickening agent. In third stage sauce formulation was calculated by adjusting the percentage of the ingredients. The chemical composition (moisture, pH, protein, fat, ash, fiber, carbohydrate, polyphenolics antioxidant) of the sauce were determined. Microbial and chemical analysis were concerned to evaluate the shelf life of sauce.

Keywords: Anti-diabetic, Anti-obesity, Functional food, *Gymnema sylvestre*

Introduction

All over the world peoples are looking for a quick, easy and convenient meal to take on due to the modern life style where, fast food is the common solution. Sauce is more popular immense fast food product. Today's consumers' interest is demand for functional foods. Nowadays, plant derived products have attracted huge attention due to their diverse range of biological and therapeutic properties. (GS) is an underutilized dicotyledonous medicinal herb belonging to the family Asclepiadaceae which is known as "Periploca of the woods" in English, *Masbadda* in Sinhala and *Chirukurinja* in Tamil. It is an underutilized and less popular but it consists of phytochemicals (Hmed *et al.*, 2007) that possess anti-diabetic and anti-obesity properties (Ali *et al*., 2010; Kishore *et al.*, 2014) but it is not popular because direct consumption is very difficult due to the bitter taste. Development of sauce from (GS) is an effective way of supply the health benefit and consuming delicious product. This study was focus to develop a sauce using (GS) leaves to assess the level of consumer acceptability with respect to required quality standards. As well as this study was evaluated physicochemical, functional properties and storage quality parameters of (GS) leaves sauce.

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Methodology

The research was conducted in three stages. In the first stage four sauce formulations were produced by changing the (GS) LEC as 50, 60, 70 and 80% (w/w). In second stage two sauce formulations were developed by changing the thickening agents as sweet potato and pumpkin. First and second sensory evaluation was done by simple ranking test. In third stage sauce formulation was calculated by adjusting the percentage of the ingredients. Moisture, protein, fat, fiber, ash and carbohydrate of leaves and sauce was determined by AOAC (2000) method. As functional properties, phenolic content, flavonoids and antioxidant capacity was found in leaves and sauce by Folin- Ciocalteu reagent method, aluminum chloride method and DPPH free radical scavenging activity respectively. Physicochemical properties of total soluble solids, pH, titratable acidity and water activity were determined. Microbial (Total plate count and yeast and mold count) and chemical analysis (titratable acidity, pH and brix) were concerned to evaluate shelf life of sauce. Non-parametric tests were used to analysis the sensory evaluation. Significant differences between the results were calculated by analysis of variance with the help of Mini tab and SPSS software

Results and Discussion

The present study was conducted with the aim of developing sauce using (GS) leaves with incorporation of health benefits and functional properties. From the first and second sensory evaluation appropriate LEC as 60% and thickening agent of sweet potato powder. In this study natural food ingredients such as sweet potato, spices, chilli, onion, ginger and garlic have been used which is an effective way to incorporate health beneficial properties to the final product.

Moisture, protein and fat contents of the leaves were significantly higher than those in sauce. Sauce have high amount of fiber, ash and carbohydrate than leaves. Total phenolic content and total antioxidant capacity of sauce is significantly higher than leaves. However, total flavonoid of leaves little higher than final sauce product. There are some standards regulations for fruit or vegetable sauce 10% m/m total soluble solids content (min), 30% m/m total solids content (min) and 1.2% m/m acidity (min).

Table 1: The proximate composition of the leaves and sauce product.

Proximate value	Amount (g/100g wet basis)	
	(GS) leaves	Sauce
Moisture	79.69 ± 1.78	73.54 ± 1.68
Total solids	20.31 ± 1.78	26.45 ± 1.68
Carbohydrate	7.17 ± 2.44	19.92 ± 2.59
Crude protein	10.29 ± 0.76	2.61 ± 0.58
Ash	2.04 ± 0.80	2.98 ± 0.44
Crude fat	0.50 ± 0.14	0.05 ± 0.01
Crude fiber	0.29 ± 0.01	0.88 ± 0.04

The decrease value of pH is correlated with increasing acidity value that commonly due to the present of lactic acid bacteria. Acidity value of sauce is inverted proportionate with the pH value. Acidity value increase is due to production of acid at low ion at low concentration during the storage. Scientific report stated that, this acidity value is influenced by sodium benzoate, vinegar and citric acid that added into product increasing of acidity value may be result from production of acid from polysaccharide degradation and sugar oxidation, or through breakdown of pectin molecule in sauce (Rahman and Thajudin, 2015). Theoretically, sodium benzoate is able to retard the growth of bacteria from Bacillaceace, Microceace, Enterobacteriaceace, mold and yeast. The benzoic acids are able to prevent microorganism from using substances that rich with energy for their growth (Despande and Salunkhe, 1995).

Following figures shows that changes of microbial count and titrable acidity changes with storage time. Shelf life studies indicated that sauce with 1000 ppm sodium benzoate as preservative was acceptable until six weeks.

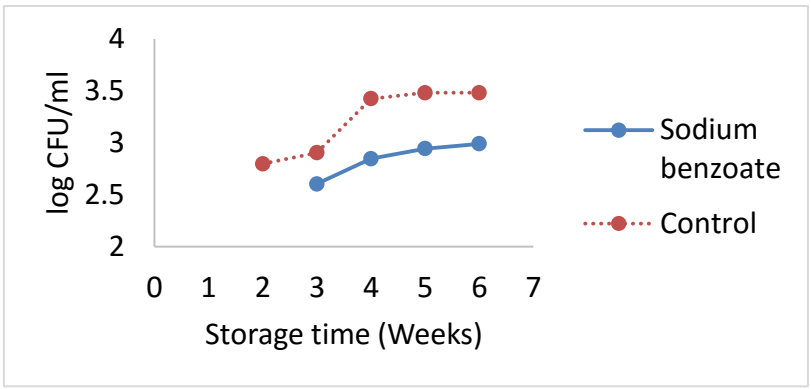

Figure 1: Changes of Total plate count (TPC) in sauce with storage time

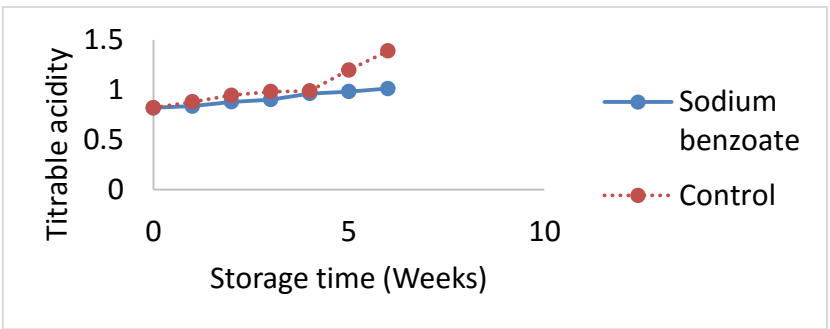

Figure 2: Changes of titratable acidity in sauce with storage time

Conclusions

This study revealed that GS leaves extract is an alternative ingredient for the production of sauce. Shelf life of the product with sodium benzoate can be predicted for six weeks. Further experiments are essential for the determination of the shelf life. Final product found as functional food.

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EFFECT OF *IN VITRO* DIGESTION ON THE ANTIOXIDANT PROPERTIES OF JACKFRUIT SEEDS AND ARILS

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Summary

The main aim of the study was to evaluate the effect of digestion in the antioxidant property of jackfruit seeds and bulbs. Mature jackfruit of Maharagama variety was selected for the study. Samples were prepared to powder form and in vitro digestion was performed using swine stomach and intestinal juice. Antioxidant activity of the digested and undigested samples was evaluated. Total phenolic content (TPC), total flavonoid content (TFC), and antioxidant assays such as 2,2-Diphenyl-1-picrylhydrate (DPPH) radical scavenging assay, ferric reducing antioxidant power (FRAP) assay and 2, 2'-Azino-Bis-3-Ethylbenzothiazoline-6-Sulfonic Acid (ABTS) radical cation decolorization assay were performed. The in vitro digestibility of jackfruit bulbs was significantly higher ($P<0.05$) than jackfruit seeds. The TPC and TFC values of samples ranged from 4.25±0.15 - 8.92±0.15 gallic acid (GAE) mg/g dry weight and 0.84±0.12 - 5.42± 0.34 mg catechin equivalent (CE)/g dry weight respectively. TPC and antioxidant activity of seeds and bulbs increased significantly after digestion while the TFC content was reduced. The FRAP and DPPH and ABTS radical scavenging activities of the digested seeds and bulbs were significantly ($P< 0.05$) higher than the undigested samples. In conclusion, it can be said that digestion of jackfruit seeds and bulbs in the body improves the antioxidant properties which can yield beneficial effects to human.

Keywords: Antioxidant activity, *In vitro* digestion, Jackfruit, Phenolic content

Introduction

A large amount of free radicals are produced during the metabolic process in the human body which have the ability to attack macromolecules such as proteins, fatty acids and nucleic acids and cause oxidative damage on cells or tissues. Free radicals at high concentration in the human body can result in oxidative stress and cause variety of chronic diseases (Li *et al.*, 2014). Cell damage caused by free radicals leads to aging and to degenerative diseases of aging such as cancer, cardiovascular disease, cataracts, immune system decline and brain dysfunction. Overall free radicals contribute to pathogenesis of at least over 50 diseases (Percival, 1998).

In maintaining optimum cellular and systemic health and wellbeing, antioxidants play a major role and they are the first line of defense against free radical damage by controlling the formation of free radicals. Antioxidants have the ability of stabilizing or

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deactivating free radicals before they attack the healthy cells (Percival, 1998).Synthetic and natural antioxidants are the two major types of antioxidants (Percival, 1998). Vitamin C, Vitamin E, carotene and polyphenols are major dietary antioxidants (Chunhabundit *et al.,* 2012). Though synthetic antioxidants are more effective than natural antioxidants (Kumar, 2011) synthetic antioxidants have toxic effects to some extent .Therefore, uptake of natural antioxidants from foods has become the first choice (Li *et al*., 2014).

The mature jackfruit (*Artocarpus heterophyllus*) is consumed in Sri Lanka either as a main meal or a meal accompaniment (Hettiarachchi *et al*., 2011). Jackfruit has phytonutrients with health benefits covering many claims from anticancer to hypertensive properties. Antioxidant properties, antiulcer qualities which good for individuals experiencing indigestion, anti-aging benefits which help to reduce the damage of cells to make skin appear supple and younger and help to reduce and cure tension and nervousness are other health benefits of jackfruit (Swami *et al*, 2012). It is vital to study how the antioxidant property of jackfruit act in our body as it is a major food in Sri Lanka. Therefore the main objective of the current study was to compare the antioxidant properties of mature jack fruit seeds and jackfruit bulbs before and after digestion with gastric and intestinal enzymes

Methodology

Well matured three Jack fruits of Maharagama variety from the same tree were collected from the Horticulture Research Farm (HRF) Unit 1, Gannoruwa, Peradeniya. Jackfruit seeds and bulbs were separated and cut in to small pieces. Samples were dried in oven (YAMATO IC 600) at 60^{O}C until a constant weight was obtained. Then samples were ground into powder form using a grinder. Finally samples were packed air tightly and stored in a desiccator until further analyses.

In vitro gastric digestion of samples was performed according to the method described by Li *et al.* (2003) and Furuya *et al.* (1978) with minor modifications.

Working samples were prepared by mixing equal weight of replicates from undigested and digested samples separately. One gram of each sample was diluted in 10 ml of phosphate buffer (pH 6.5) and heated at 60^{O}C for 1h and 30 minutes in water bath (Memmert, Germany). After incubation, supernatant was removed by centrifugation at 1250×g for 20 minutes using centrifuge (Eppendorf, Germany).

Total phenolics content and total flavonoid content were adapted from Singleton and Ross (1965) and Samatha *et al.,* (2012) respectively with slight modifications. The DPPH assay was done according to the method of Brand-Williams *et al.,* (1995) with some modifications. For ABTS assay, the procedure followed the method of Arnao *et al.,* (2001) with some modifications. The FRAP assay was done according to Al-Farsi *et al.,* (2005) with some modifications.

Results and Discussion

Weight of both mature jackfruit seeds and arils were significantly reduced after digestion with gastric and intestinal juices. Weight of the digested residues of jackfruit seeds and arils were 0.80±0.03 g and 1.41±0.07 g respectively. Therefore, digestibility

of jackfruit arils was higher than jackfruit seeds. High content of resistant starch in jackfruit seeds (Sarmin and Chowdhury, 2014) could be the reason for less digestibility. Total Phenolic content of jackfruit seeds and arils were higher after digestion and highest TPC content was observed in digested arils. But the TFC was decreased after digestion of both seeds and arils. Antioxidant activity was significantly increased after digestion of jackfruit seeds and arils according to the results obtained from DPPH, ABTS and FRAP assay. Antioxidant activity was high in digested jackfruit arils than in seeds

Table 01: Weight of the samples before and after digestion, antioxidant composition and antioxidant activity of jackfruit seeds and bulbs.

	Weight (g)	TPC (GAE mg/g)	TFC (CE mg/g)	DPPH IC_{50} (mg/L)	ABTS (mM TE/100g)	FRAP (mM Fe^{2+}/g)
Undigested seeds	1.00	4.25± 0.1^{d}	2.88± 0.11^{b}	18.94± 2.49^{a}	19.04± 0.81^{c}	12451± 243.16^{d}
Undigested bulbs	1.00	5.45± 0.24^{c}	5.41± 0.34^{a}	16.56± 1.25^{a}	27.85± 0.30^{b}	14544± 155.68^{b}
Digested seeds	0.80 ±0.03	7.07± 0.44^{b}	0.84± 0.12^{c}	10.43± 0.65^{b}	27.05± 0.19^{b}	13064± 53.89^{c}
Digested bulbs	0.41 ±0.07	8.92± 0.15^{a}	Not detected	5.97± 0.79^{c}	29.85± 0.17^{a}	15662± 274.25^{a}

Mean (± SD) with different superscripts in each column are significantly different ($P<0.05$).

Conclusions

The results from the current study indicate that in vitro gastric enzymatic digestion could increase the antioxidant activity of jackfruit seeds and bulbs. Increasing antioxidant activity after digestion at the colon has health benefits. Therefore, it is important to increase the consumption of mature jack fruit bulbs and seeds among the people as they are beneficial natural antioxidant sources in Sri Lanka. Present study has performed only on Maharagama variety of jackfruit. It is important to study on other varieties which are commonly used for the consumption and it will help to identify the best variety of jackfruit for consumption.

Acknowledgement

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CONSUMER BEHAVIOR AND AWARENESS ON PRE-WASHING CYCLES AND NUTRITIONAL VALUE OF RICE, IN IMBULPE DIVISIONAL COUNCIL AREA

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Summary

Majority of the people are having sufficient knowledge on ways of nutritional losses can occur in rice while cooking. At present rice available in market are unwashed, and contain dust, stones, dyes, odors and chemicals due to poor manufacturing practice done by the processors at the time of processing. So that consumers have to perform high number of washing cycles by using large quantity of water prior to cook it. They have to spend considerable time period for that, but have not any idea on how much nutrients remain in the rice. There is a responsibility and also a good demand to produce rice packets under Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP). So by considering this demand manufactures can produce rice packets which are chemically, physically and biologically safe for the human consumption by washing to optimum level and adjusting the nutrient content by enrichment. This method is performed by many countries however still it is not available for the common rice varieties available in Sri Lanka. This is a huge gap presence in Sri Lankan rice market.

Keywords: Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP)

Introduction

Rice is the staple food of many Sri Lankans and a good source of protein, essential amino acids, magnesium, iron, calcium like minerals and thiamine, riboflavin, niacin like vitamins. Even though, a number of nutritional problems are prevailing in rice consuming countries than others (Bienvenido, 1993). It leads to widespread prevalence of protein energy malnutrition (PEM), nutritional anaemia (particularly from iron deficiency) and vitamin deficiencies (Khor *et al.*, 1990). According to the latest reports 22% of Sri Lankan women and 25% of children between 6-59 months are anemic due to iron or vitamin or mineral deficiency. 18% are suffering from malnutrition (Jayatissa, 2010). If the research values on nutritional content of rice are much more similar to the real values of the cooked rice, no one can expect much nutritional problems in rice consuming countries than others. The reason for this variation is some poor milling operations and/or cooking practices. "Prior to cook, should we need to wash rice or not" is also a current debating topic in the world and also washing of milled rice prior to cooking is a common practice in Sri Lanka. Consumer behaviour and awareness are key

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factors which can used to determine presence of any problem with the cooking practices on nutritional value of rice.

Materials and Methods

A questionnaire was designed based on dietary patterns and cooking practices with related to the rice. By using the prepared questionnaire, data were collected from 160 houses which are located in Imbulpe divisional council and covered all Grama niladhari divisions. In each and every evaluated house, habitual method of cooking 500 g of rice was asked to perform. In here total amount of water used for the washing of rice and time period spend for the rice washing was measured. Then all the collected data were evaluated by using Statistical Analysis Software (SAS) 9.3.

Results and Discussion

A total of 651 people including 133 children are living in those houses. Out of those people 95% usually consume red rice which contains less bran and rests of the population consume red rice and parboiled rice. Nearly half (58%) of people prefer to consume "Suwandel" which has high nutritional and health benefits and 26 % prefer to consume Kaluheenati. Some people (12%) do not have a proper idea regarding traditional rice varieties and their benefits. Consumption level of traditional rice varieties is comparatively very lower than the other varieties available in the market. Mean number of pre-washing cycles complete by this selected sample is 2.318±0.788. Mean quantity of water used to wash 500 g of rice sample is 2.234±1.035 liters. A large percentage (90%) of the people completes prewashing cycles of rice within five minutes. From the selected sample 75% consume rice for all the three meals. Average rice consumption level per house is 40.093±13.28 Kg per month in Imbulpe divisional council area. 83 % of people aware regarding the impact of pre-washing cycles on nutritional value of rice. However, they complete 1 to 4 washing cycles to remove bran, dust, stones, dyes, paddy husk, odors and chemicals in rice.

Even traditional rice varieties have high nutritional and health benefits than other varieties, those are lacking in the market and labeled as high price. Therefore, consumers tend to consume low price rice varieties which having considerably high amount of nutrients like red rice. Majority of people add rice for their all meals, because they believe rice is the best food for their children and them to perform daily works. But due to presence of number of physically, chemically and biologically unwanted materials in rice, people have to complete high number of washing cycles even they are aware regarding the nutritional losses. In some cases some people perform high number of washing cycles even rice do not contain any unwanted materials due to their unnecessary fear and habitual behaviour. Numbers of pre-washing cycles complete and amount of water used are the main key factors which can make an impact on nutritional value of rice. However in some cases, people add much more water into rice when they are going to cook rice. But during the cooking process they remove additional water. That water may contain high amount of nutrients. Because Rice contains many nutrients which are soluble in water like amino acids, albumin like proteins, polysaccharides, crude fat, zinc and potassium like mineral, panthothenic acid like vitamins. Sri Lankan

rice samples contain different size of rice particles. Due to this size variation also sometime people need to remove some amount of water during the cooking process. These practices may effect for the nutrients which may present in the rice. So that, preparation of rice packets with consistent nutritional level is very important

Conclusion

Rice washed water is used for punnac preparation due to presence of considerable amount of nutrients and to wash potteries in drought season. Even people having the knowledge, in some cases they cannot do anything other than washing rice until it reach to their level of acceptable. Producers should try to produce quality rice by using GHP and GMP for human consumption. Use of high number of pre-washing cycles, use of large quantity of water while washing, use high quantity of water while cooking rice and remove excess water while cooking are the main key points which can make an problem in nutritional value of rice. All these consumer related problems can overcome, if manufacture can produce clean enriched rice which contains equal size particles. If so, consumers do not need to wash rice prior to cook. Impact of washing cycles on nutritional value of rice is lightly touched key research area in today world.

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COMPARATIVE STUDY ON PHYSICOCHEMICAL PROPERTIES OF IMPORTED AND LOCALLY PRODUCED MILK POWDERS IN SRI LANKA

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Summary

The objective of this study was to investigate the physicochemical properties of shelf available milk powders which are commonly available in Sri Lankan market and compare them with the international quality standards. Altogether 30 milk powder samples were tested including two locally produced and four imported milk powder brands. Present study results revealed that FFA levels in imported milk powders exist within the acceptable range while it is two times higher than acceptable limits in locally produced milk powders. All the other chemical properties including fat, protein, ash, Ca, pH, moisture and water activity were within the acceptable standard levels in both local and imported milk powders. Imported milk powder brands had higher bulk density and particle density than local brands except imported milk powder brand A which showed the lowest bulk density and particle density values in physical property analysis. The insolubility index values revealed that locally produced milk powders have a significantly lower solubility than imported milk powder brands suggesting different processing conditions and quality attributes between locally produced and imported milk powder brands.

Keywords: Milk powder, Physicochemical properties, Free fatty acids, Insolubility index

Introduction

Milk powder is produced by evaporation of water from liquid milk to dryness. Major purposes of milk powder production are preservation of liquid milk and to obtain a prolonged shelf life while little or no detrimental changes compared to original liquid milk (Walstra, 1999). Milk powders possess various physical and instant properties which are important to both industry and consumer. Among them, particle size, shape, moisture content, bulk density and particle density are categorized as physical properties. As well as, instant properties include flowability, wettability, sinkability, dispersability and solubility (Sharma *et al.*, 2012).

Solubility indicates the degree of scorched particle, protein denaturation and status of protein in the milk powder. Insolubility may affect processing difficulties and economic losses as well as negatively affect to other functional properties of milk powders such as emulsification, gelation, foaming and whipping properties (Paracha, 2013).

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According to the Department of Census and Statistics (2014), average milk powder importation of Sri Lanka (62690 MT) has been increased nearly by 7 times from 1998 to 2012 compared to locally produced milk powders (9160 MT). Even though higher consumer demand reflects the necessity of milk powder, there is a less consumer preference for locally produced milk powders due to their low solubility and it has become one of the major reasons for higher preference for imported milk powders. The aim of this study was to compare the solubility of the commercially available milk powders in Sri Lanka and assess the physicochemical properties which can affect milk powder solubility

Methodology

Experiment was performed using most commonly available four imported milk powder brands (Brand A, B, C, D) and two locally produced milk powder brands (Brand E, F) available in Sri Lankan market, using thirty milk powder sachets as five biological replicates from each brand. A control milk powder sample was prepared by spray drying of fresh milk sample using a spray dryer (L-8 No. 7084, Ohkawara Kakohki Co. Ltd, Japan).

Chemical Property Analysis

The contents of moisture, protein, fat and ash contents were determined according to AOAC methods (AOAC, 1990). Free fatty acid content of milk powder samples was determined using extraction titration method as described by Vidanarachchi et al., (2015). Total Ca content of the powders was analyzed using atomic absorption spectrophotometer (AA-6200, Shimadzu, Japan) against standard series of Ca solution. Water activity of powder samples were determined using water activity meter (Hygrolab 3, Rotonic Instruments, Japan) and pH determination was carried out using a pH meter (Model: 775249 Eutech, Singapore).

Physical Property Analysis

Bulk density and particle density were determined by was determined by sifting milk powder into a 100 ml cylinder and then weighing (AOAC 1990). Solubility was measured by insolubility index method which is described by IDF 129 | -ISO 8156 (Standard, 2005).

Statistical Analysis

Significance of each physical and chemical property among milk powder brands were analyzed using one way ANOVA by using Complete Randomized Design (CRD). Mean separation was done by Duncan's Multiple Range Test. Relationship between each physical and chemical property with solubility was analyzed using regression and correlation.

Results and Discussion

Proximate composition of the milk powders is presented in Table 01. None of the milk powder brands has exceeded the acceptable limit of moisture content (CODEX; 207,

1999). Imported milk powder brands have significantly higher moisture content than locally produced milk powders except brand C. Physicochemical stability of milk powder varies with moisture content during storage and distribution and functional properties like wettability or solubility can be affected by moisture content (Reh *et al*., 2004). Water activity in milk powder could vary from 0.2 to 0.6 and the results reveals that water activity of tested milk powder brands ranged between 0.33-0.39. As shown in Table 01, the fat content of milk powder samples varies between 23-29% while minimum fat content in whole milk powder should be 26% (w/w) (CODEX; 207:1999). According to the results imported milk powder brand C and locally produced milk powder brand F do not contain the minimum acceptable fat content. Sulieman *et al*. (2014) have found that low water activity, moisture content, fat content and higher insolubility may result due to high spray drying temperatures. Perhaps it can be suggest that, higher spray drying temperatures might have used during local milk powder manufacturing process compared to imported milk powder manufacturing process.

Table 01: Chemical properties of whole milk powder available in Sri Lanka (all values are presented as the means ± S.D for five replicates analysis)

Milk powder brand	Protein content (%)	Fat content (%)	Moisture content (%)	Water activity	Ca content (mg/100g)	Ash content (%)	pH
Control	29.4 ± 2.5^{a}	17.1 ± 0.4^{d}	1.02 ± 0.2^{c}	0.30 ± 0.01^{d}	736.3 ± 135^{a}	6.70 ± 0.4^{a}	7.06 ± 0.13^{a}
Brand A	23.6 ± 0.4^{d}	29.3 ± 1.9^{a}	2.54 ± 0.6^{ab}	0.38 ± 0.02^{a}	424.6 ± 047^{c}	5.60 ± 0.6^{c}	6.88 ± 0.09^{ab}
Brand B	23.7 ± 0.5^{d}	26.6 ± 1.0^{ab}	3.10 ± 1.0^{a}	0.39 ± 0.00^{a}	471.3 ± 031^{bc}	5.25 ± 0.2^{c}	6.74 ± 0.27^{bc}
Brand C	20.3 ± 0.9^{e}	23.3 ± 1.3^{c}	2.00 ± 1.1^{abc}	0.39 ± 0.02^{a}	445.7 ± 062^{bc}	4.05 ± 0.3^{d}	6.74 ± 0.28^{bc}
Brand D	24.3 ± 0.3^{cd}	26.6 ± 1.8^{b}	2.70 ± 1.0^{ab}	0.38 ± 0.02^{ab}	477.1 ± 040^{bc}	5.55 ± 0.3^{c}	6.56 ± 0.24^{c}
Brand E	26.4 ± 1.6^{b}	26.3 ± 1.6^{b}	1.73 ± 0.9^{bc}	0.33 ± 0.01^{c}	567.8 ± 095^{b}	6.28 ± 0.5^{b}	6.91 ± 0.18^{ab}
Brand F	25.6 ± 1.0^{bc}	23.6 ± 1.2^{c}	2.50 ± 0.8^{ab}	0.36 ± 0.01^{bc}	497.3 ± 101^{bc}	5.64 ± 0.2^{c}	7.04 ± 0.17^{a}

Column mean value with different superscript letters are significantly different at ($p<0.05$).

Table 02: Mean values (±S.D) for bulk density, and particle density of commonly available milk powder brands in Sri Lanka

	Control	Brand A	Brand B	Brand C	Brand D	Brand E	Brand F
Bulk density	0.32 ± 0.01^{e}	0.55 ± 0.01^{d}	0.61 ± 0.00^{ab}	0.60 ± 0.00^{a}	0.60 ± 0.01^{ab}	0.58 ± 0.01^{cd}	0.60 ± 0.01^{cd}
Particle density	0.91 ± 0.02^{b}	1.15 ± 0.01^{a}	1.14 ± 0.07^{a}	1.15 ± 0.05^{a}	1.20 ± 0.07^{a}	0.99 ± 0.04^{b}	1.11 ± 0.03^{a}

Column mean values with different superscript letters are significantly different ($p<0.05$).

None of the imported milk powder brands fulfill the minimum required protein level while all the local milk powder brands are in line with the standard levels. Milk powder consists of approximately 4% whey protein and 20% casein protein and higher casein content together with protein cross linking leads to lower solubility of milk powders.

Therefore removal of protein to a certain level could be practiced by the manufacturers as a solubility improving strategy (Anema *et al.*, 2006).
Due to the improved level of free fat milk powder may prone to higher fat oxidation resulting poor rewetting properties (Kelly *et al*., 2002). Imported milk powder brands had lower amounts of FFA level and in line with the standard levels whereas locally produced brands had two folds higher ($P<0.05$) FFA level than imported milk powder brands (Figure 02) exceeding the standard level. Ash content, Ca content and pH of the locally produced milk powder brands are higher ($P<0.05$) than the imported milk powder brands (Table 01). Except the control sample, all the other samples had bulk density and particle density values according to the standards and both properties shows a positive correlation with the solubility.

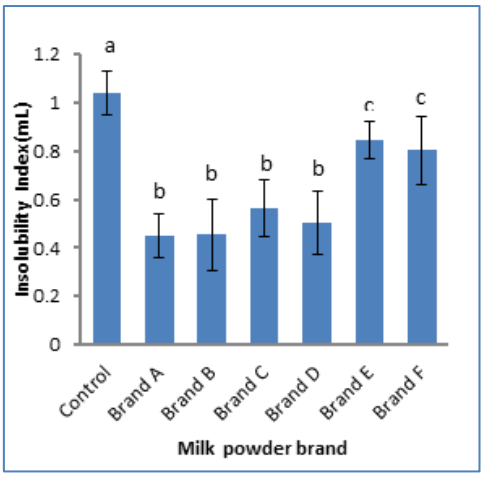

Figure 01: Variation of insolubility index among commercially available milk powders in Sri Lanka

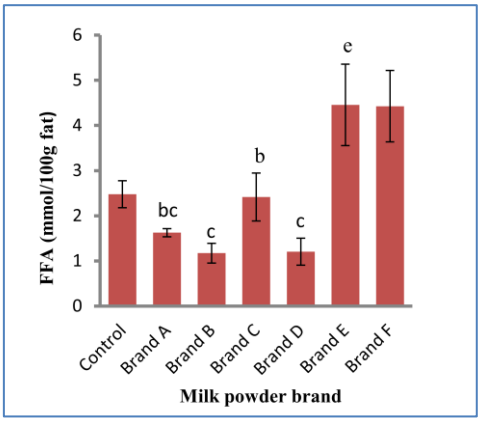

Figure 02: Variations of free fatty acids levels (mmol/100g fat) in commercially available milk powder brands in Sri Lanka

Solubility is one of the major functional properties of milk powders which mainly depend on the chemical composition and physical state of the milk powders. According to the present study results, insolubility index of milk powders ranged between 0.45-

0.85 mL (Figure 01) and all the tested milk powder brands had accepted insolubility index values as recommended by local and international standard bodies. The locally produced milk powders had higher insolubility index values while imported milk powders had lower insolubility index values indicating that the imported milk powders possess significantly higher solubility than the locally produced milk powders.

Conclusion

Physical and chemical properties of imported and locally produced milk powders tested in the current study were within the international standard levels except the free fatty acid content. Solubility of the locally produced milk powders was lower than the imported milk powder brands suggesting different manufacturing conditions and compositional changes among local and imported milk powder brands.

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EVALUATION OF ANTIOXIDANT ACTIVITIY AND CHEMICAL PROPERTES OF KOMBUCHA 'TEA FUNGUS' DURING EXTENDED PERIODS OF FERMENTATION

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Summary

Kombucha tea is a slightly sweet, slightly acidic refreshing beverage consumed worldwide. It is obtained from infusion of tea leaves by the fermentation of a symbiotic association of bacteria and yeasts forming the 'tea fungus'. There are conceptions and misconceptions regarding the health benefits and toxicity of Kombucha beverage. The objective of this study is to find Physical parameters and beneficial antioxidant properties of Kombucha 'Tea Fungus' during 2 months of fermentation, which has not been investigated to date. Both Total Soluble Solids and pH decreased over 8 weeks of fermentation period. Total phenolic content of Kombucha samples had not significantly ($p>0.05$) increased with the fermentation time. ORAC value of the Kombucha beverages prepared using higher concentrations of tea leaves T-3F and T-4F presented higher antioxidant activity. However, DPPH radical scavenging potential was significantly decreasing over the 2 months of fermentation. Overall, the Kombucha samples displayed a decrease in the antioxidant activity during 2 months of fermentation.

Keywords: Kombucha, Fermentation, Antioxidant, DPPH

Introduction

The Kombucha fermentation is traditionally carried out by inoculating a previously grown culture into a freshly prepared tea decoction and incubated statically under aerobic conditions for 7 - 10 days. Eventually, a pleasantly sour and slightly sparkling beverage is produced. A representative image of the Kombucha beverage in preparation is shown in Figure 1. 'Kombucha' is derived from the Japanese words 'seaweed' (Kombu) and 'tea' (cha) (Ernst *et al*., 2003). It tastes like sparkling apple cider and can be produced in the home by fermentation using mail order fungus or locally available tea fungus. Though green tea can be used for Kombucha preparation, black tea and white sugar are considered the finest substrates for the preparation of Kombucha tea. The beverage has been claimed to be a prophylactic agent which is beneficial to human health; however, further research is needed to evaluate the toxicity and safe limits of the

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product for human consumption (Chen *et al*., 2000). Prolonged fermentation after two months is not recommended because of the accumulation of organic acids, which might reach harmful levels for direct consumption. The changes in antioxidant activities of Kombucha for more than one week of fermentation have not been investigated. Additionally, although previous studies have highlighted the anti-microbial properties of the fermented broth, this aspect has not been fully elucidated and neither has this property been investigated for extended periods of fermentation. In addition, evaluation of physio-chemical qualitative characteristics such as total soluble solids content and pH are important from the perspective of consumer acceptability of the fermented beverage. The objective of this study is to evaluate the changes in antioxidant and qualitative properties of Kombucha 'Tea Fungus' which has undergone fermentation for 2 months

Methodology

Sugared black tea was prepared by addition of Sri Lankan black tea in to boiling water and allowed to infuse for 5 min. Different tea concentrations were prepared by changing the amount of Sri Lankan black tea. The concentrations of tea samples prepared are shown in Table 1. Infusion was filtered using sterile sieve. Brown sugar Throughout the fermentation, the beverage was covered with a Parafilm to avoid contamination from external micro-organisms. The following physical and chemical parameters were evaluated prior to inoculation of tea with the tea fungus, 1 day after the fermentation and followed by weekly analysis was done for a total period of 2 months. pH value of Kombucha and Total soluble solids (TSS) were evaluated as physical parameters. Antioxidant activity parameters of Total phenolics content (TPC), Oxygen radical absorbance capacity (ORAC) assay and DPPH radical scavenging assays were determined using Synergy™ HTX Multi-Mode Microplate Reader (BioTek Instruments, Winooski, VT, USA) with Gen5™ software. TPC results were expressed as gallic acid equivalents (GAE) per mL and ORAC was measured in terms of Trolox equivalents (TE) per mL. All data presented as means of at least three independent experiments ($n \geq 3$), with each experiment having a minimum of three replicates of each sample. Data analyzed by ANOVA. A probability $P<0.05$ is considered statistically.

Results and Discussion

The reduction of TSS over the fermentation period may be due to the uptake of soluble solids of the extract by the Kombucha tea fungus during the fungal mat Development. Similarly, the pH value would have decreased due to the increased concentration of organic acids producing during the fermentation process by bacteria and yeasts in the tea fungus.

The total phenolic content of Kombucha samples had not significantly increased with the extended fermentation time. This was being observed for the first time, since many of the previous studies focused on 7 – 10 days of fermentation. Tea 3 - F displayed a higher total phenolic content in week 1. Nevertheless, quantity of the total phenol

content did not always determine the antioxidant activities of Kombucha whereas the types of metabolites produced might have had the key effect instead (Chen *et al*., 2006) The ORAC value of the Kombucha beverages prepared using a higher concentration of tea dust Tea 4 – F displayed a higher antioxidant activity. However, the increase in the ORAC values as fermentation progressed was gradual as compared with previous studies.

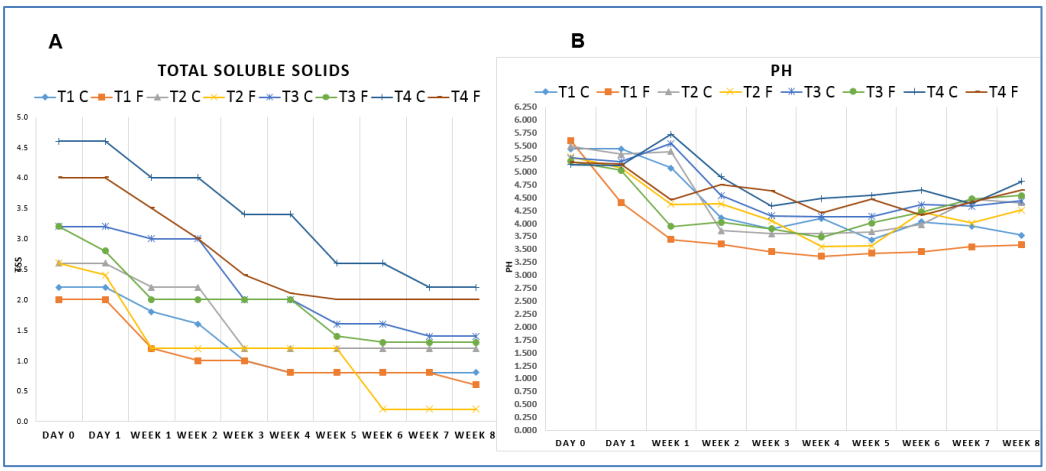

Figure 1: Changes to the (A) Total Soluble Solids content and (B) pH of the Kombucha beverages and their controls

The Total Soluble Solids decreased at a slower rate with time for the 8 weeks of fermentation period. The pH of Kombucha samples decreased with fermentation time. It shows a rapid decrease from 2 weeks of fermentation and continued to decrease to some extent up to 8 weeks.

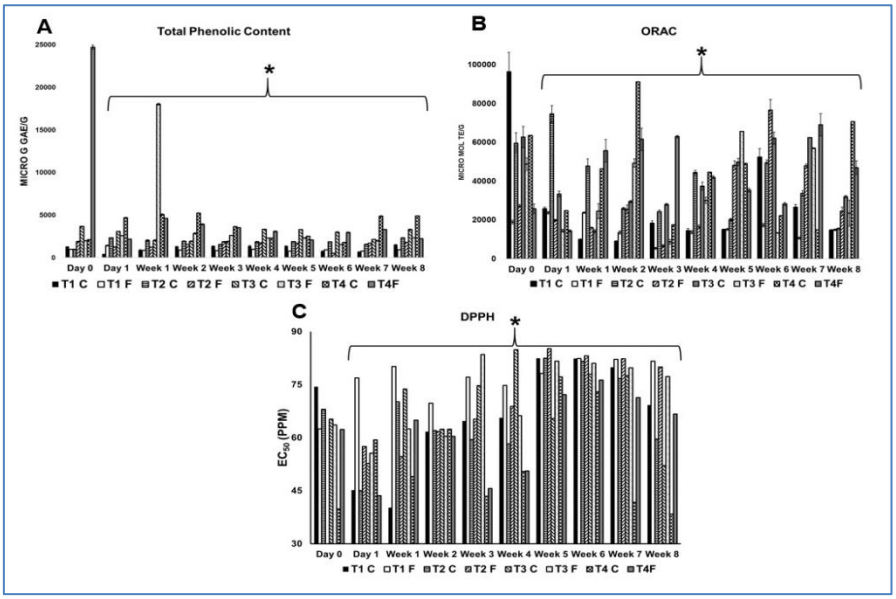

Figure 2: (A) Total phenolic content (B) ORAC and (C) DPPH scavenging activities of the four Kombucha beverages and their controls

The DPPH scavenging properties of fermented samples had significantly increased with the fermentation time, which indicated that the antioxidant activity in terms of DPPH radical scavenging potential was significantly decreasing. Exposition of various radical scavenging properties of Kombucha samples might be associated with the starter culture. Deviations showed are related to the sources and affected the metabolic fate of culture broth (Liu *et al*., 1996; Martin *et al.*, 1995; Mayser *et al*., 1995)

Conclusions

The results obtained from the study are the first of its kind given that there have been only a few reports about the extended periods of fermentation of Kombucha. Higher tea concentrations (T-3F, T-4F) displayed higher antioxidant activity. Overall, the Kombucha samples displayed a decrease in the antioxidant activity during the 2 months of fermentation which was suggestive that the functional properties of the beverage had decreased. Additionally, although not investigated in this study, it is possible that prolonged fermentation may result in the accumulation of organic acids, which might reach harmful levels for direct consumption.

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EFFECT OF H_2O_2 IN REDUCING COLIFORM CONTAMINATION OF INGREDIENTS USED TO PREPARE UNROASTED CURRY POWDER

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Summary

In this study, hydrogen peroxide was applied to reduce the coliform contamination of spices used in preparing unroasted curry powder. The treatments were applied using different concentrations of food grade H_2O_2 solution and soaking time: T1- 1%, 10 min, T2- 0.5%, 10 min, T3- 0.1%, 10 min, T4- 0.5%, 5 min, using 1:5 ratio between material and H_2O_2. Coliform population reduction (CPR) obtained in log10 CFU/g for cumin, fennel, turmeric and unroasted curry powder were T1- 6.05, 5.17, 3.42 and 5.07, T2- 4.16, 5.17, 3.29 and 4.85, T3- 2.91, 2.86, 2.71 and 4.22, T4- 3.1, 2.88, 2.85 and 4.25 respectively. All the treatments were enough to obtain 1.78 log10 CFU/g population reduction (PR) of *E.coli* in fennel. This finding is useful in reducing the coliform contamination of spices in cost effective way and thereby increase the export market.

Keywords: Spices, Unroasted curry powder, Coliform, Hydrogen peroxide, Microbial specification

Introduction

Spices are often exposed to a wide range of microbial contamination at both preharvest and postharvest operations. Pathogenic bacteria contaminating spices can be hazardous when used in processed foods, particularly when they are used in foods that are consumed without further cooking (Anonymous, 2000). Spice industries in Sri Lanka face problems in exporting Sri Lankan curry powder because of the coliform count higher than the microbial specification of the importing countries. H_2O_2 is a powerful oxidizer and through oxidation, the bacteria decompose, reduce the microbial load (Sabrina, 2012). The overall objective of this research was to assess the efficacy of different concentrations of H_2O_2 solution to reduce the coliform population in the spices used in preparing unroasted curry powder.

Methodology

Each 1.5 kg of Coriander, cumin, fennel, fenugreek seeds, turmeric rhizome, clove (500 g), pepper (500 g) and cardamom (400 g) were cleaned, sorted and divided into five, packed using LLDPE pouches and named as control (I), T1, T2, T3 and T4 for the application of treatments. Each spice of control was ground individually using a cleaned

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blender. Unroasted curry powder (URCP) of 100 g was prepared by mixing coriander (76 g), cumin (9 g), fennel (6 g), fenugreek (4 g), turmeric (2 g), pepper (1 g), clove (1 g) and cardamom (1 g). URCP and spices were tested for coliform and *E. coli* according to the method given in AOAC, 2010 using 3M petrifilm and the moisture content (MC) was measured using a calibrated IR moisture meter.

Spices not contaminated with coliform: coriander, fenugreek and clove were washed with tap water twice and spread in stainless steel trays. Spices contaminated with coliform: cumin, fennel, turmeric, pepper and cardamom of each treatment were washed with tap water twice and then the treatments were applied using different concentrations of food grade H_2O_2 solution and soaking time: T1- 1%, 10 min, T2- 0.5%, 10 min, T3- 0.1%, 10 min, T4- 0.5%, 5 min, using 1:5 ratios between material and H_2O_2 and then drained. Spices were dried using a hot air drier (Made in Sri Lanka) at 65^{O}C until the MC becomes < 10 (ISO standard). They were ground individually using a blender and kept in Mac/PET containers. URCP of 100 g was prepared and each spice powder was tested for coliform and *E. coli*. Water sample and swab samples of blender before grinding the sample T1, T2, T3 and T4 were tested for coliforms. The CPR was analyzed and compared with the standards of some countries (Adams, 2008).

Results and Discussion

All eight spices and the unroasted curry powder of control were complied with the specification (10% by mass max) given by SLSI and ISO for moisture. Among the control sample, coliform was not detected in coriander, fenugreek and pepper and other spices were contaminated with coliform. Cumin was observed to have the highest coliform population and pepper was less. Among the eight spices, only fennel was contaminated with *E. coli* and other spices were negative. This deviation might be due to the pre-harvest and post-harvest practices and handling of particular spices.

Table 1: Initial moisture content of spices on dry basis

Spice	Initial MC (%)
Coriander	7.9
Cumin	4.5
Fennel	6.0
Fenugreek	5.7
Turmeric	7.6
Pepper	7.3
Clove	9.3
Cardamom	8.5
Unroasted curry powder	6.4

Final moisture content was < 10 % (db) for all the spices and URCP after all the treatment. *E. coli* was not detected in tested spices after each treatment and PR of 1.78 log10 CFU/g was observed in fennel for all the treatments.

Coliform population reduction obtained in log10 CFU/g for the tested spices: cumin, fennel, turmeric and URCP were T1- 6.05, 5.17, 3.42 and 5.07, T2- 4.16, 5.17, 3.29 and 4.85, T3- 2.91, 2.86, 2.71 and 4.22, T4- 3.1, 2.88, 2.85 and 4.25 correspondingly.
Both the blender and the water were negative for coliform. So, there was no cross contamination to the materials by water or the blender.
When compare all four treatments, T1 and T2 were adequate to reduce the coliform count to < 2 log10 CFU/g in cumin, fennel and URCP and up to the satisfactory levels for spices given by Netherland, Philippines and South Africa and reduce the *E. coli* population in fennel up to the standards given by Netherland, Philippines, South Africa, Germany and European commission. This treatment was most suitable to reduce the coliform population of turmeric up to the satisfactory level given by South Africa and up to the acceptable level given by Philippines, but not up to the satisfactory level given by Netherland.

Table 2: Initial coliform and *E. coli* population in spices (ND: Not Detected

Ingredient	Coliform		*E.coli*	
	(CFU/g)	(CFU/g)	(CFU/g)	(log_{10} CFU/g)
Coriander, Fenugreek, Clove	ND	ND	ND	ND
Cumin	$1.13x10^6$	6.05	ND	ND
Fennel	$1.48x10^5$	5.17	$6.0x10^1$	1.78
Turmeric	$6.7x10^5$	5.83	ND	ND
Pepper	$4.9x10^2$	2.69	ND	ND
Cardamom	$1.18x10^3$	3.07	ND	ND
Unroasted curry powder	$6.0x10^6$	6.78	ND	ND

Table 3: Coliform count after T1, T2, T3 and T4 (ND: Not Detected, PR: Population Reduction)

Spices	T_1			T_2			T_3			T_4		
	Coliform count		PR	Coliform count		PR	Coliform count		PR	Coliform count		PR
	CFU/g	log_{10} CFU/g	log_{10} CFU/g	CFU/g	log_{10} CFU/g	log_{10} CFU/g	CFU/g	log_{10} CFU/g	log_{10} CFU/g	CFU/g	log_{10} CFU/g	log_{10} CFU/g
Cumin	ND	ND	6.05	$7.8x10^1$	1.89	4.16	$1.37x10^3$	3.14	2.91	$8.9x10^2$	2.95	3.1
Fennel	ND	ND	5.17	ND	ND	5.17	$1.9x10^2$	2.28	2.86	$1.8x10^2$	2.26	2.88
Turmeric	$2.6x10^2$	2.41	3.42	$3.5x10^2$	2.54	3.29	$1.33x10^3$	3.12	2.71	$9.6x10^2$	2.98	2.85
URCP	$5.2x10^1$	1.71	5.07	$8.6x10^1$	1.93	4.85	$3.6x10^2$	2.56	4.22	$3.4x10^2$	2.53	4.25

By considering the cost, T2 is more economical to be applied to medium scale spice industries as it is a very simple, cost effective when compared to the fumigation (ethylene oxide and propylene oxide), irradiation and steam sterilization (ASTA, 2011).
This experiment was designed only to check the coliform population reduction in some spices by applying H_2O_2. Reduction in total plate count, yeast and molds count and other pathogenic microbial count should also be studied to check the complete effectiveness.

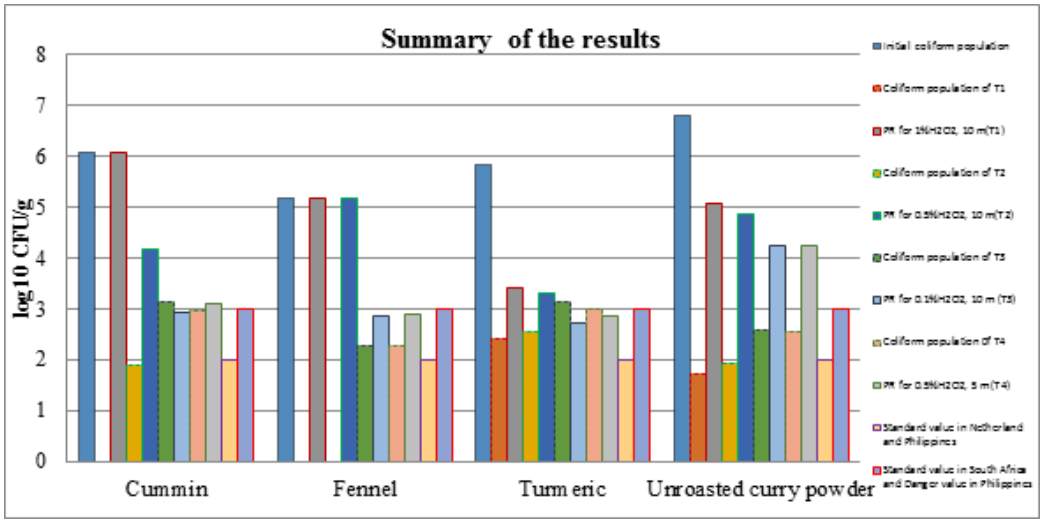

Figure 1: Summary of the results, PR- Population reduction, m-Minutes

Conclusion

Soaking of spices in 0.5% H_2O_2 solution for 10 min (T2) was the most suitable and economical to reduce the coliform population in cumin, fennel and unroasted curry powder to the count < 2 log10 CFU/g.

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DEVELOPMENT OF VEGANS CUPCAKES USING DURIAN SEED FLOUR; AN ATTEMPT TO REPLACE THE USE OF POULTRY EGGS

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Summary

Durian (*Durio zibethinus*) is one of the most popular seasonal fruits in Sri Lanka. Only one third of the durian fruit is edible and the seeds are disposed as a waste. This waste is containing the hydrocolloids which can be used in the applications of food industry. Cake is a food that uses eggs as an emulsifier, moistener to develop the textural properties. Due to incorporation of eggs it becomes unpopular among vegetarian people. Therefore, in this research durian seed flour (3.6%, 4.8% and 6%) has been used to replace the eggs for making a vegan cup cake. Sensory evaluation was practiced for taste, texture, appearance, color, overall acceptability of the cupcakes. Data were analyzed using Kruskal Wallis non parametric one way ANOVA (STATISTIXS Ver.10 software) and the best formulation of vegan cupcake with 4.8% durian seed flour was tested for the shelf life and the proximate analysis. According to the microbiological tests, the shelf life of the cupcake which was made without using any preservatives in ambient temperature was 5 days. The percentage of Moisture, Carbohydrate, Protein, Fat, Crude Fiber and Ash of the final product were 17.2%, 73.68%, 1.4%, 5.23%, 1.49%, and 1.0% respectively. The final product of durian based vegan cupcake was priced as Rs 12.4 and the cost reduction was approximately 28.22% when compared to the egg cup cake. According to the final results of the study, it can be concluded that the durian seed flour can be used to replace eggs in the cupcake production and it produces a fairly stable emulsion and good texture to the cupcakes.

Keywords: Durian seed flour, Emulsion, Vegan cupcake, Sensory evaluation

Introduction

Cakes are produced including the eggs as an ingredient to give the dough a light, airy texture and it acts as a binder, to hold the cake together and it can be used as emulsifier, moistener and, nutritionally, as a source of fat and all the essential amino acids. Egg incorporated cakes cannot meet the needs of the people who fall in to the category of vegetarians.

Durian seeds contain a gum with slimy properties that can be used as a gelling agent, thickener, stabilizer and emulsifier (Amiza, 2006). Utilization of the durian seed is still limited due to lack of knowledge of its nutritive and potential application in food industry. Use of this agricultural waste as a source of valuable materials is a commercially important attempt. The flour made out of the seeds are tested to be used

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as the emulsifying agent for replacing eggs in production of cakes. Therefore this research is targeting to provide a cup cake that can match with the food habits of the vegetarian people by using the durian seed flour instead of using eggs for the task.

Methodology

Durian flour, wheat flour, margarine, sugar and baking powder and vanilla extract were measured. Durian solution which replaces the egg mixture was prepared by adding water to durian flour to form the durian solution which may have the emulsifying activity as an egg. Then all the ingredients were mixed well by using an electronic mixer for 10 minutes. The mixture was poured in to a cake tray and kept for 45 minutes at 180^{O}C.

Preliminary studies were conducted to produce durian seed flour from durian seed by identifying the slimy properties of raw durian seeds, Making durian seed flour and identifying the slimy properties of durian seed flour. Thin slices (about 2mm) of fresh durian seeds were dried in an oven at 45^{O}C until the constant weight is obtained and it was pulverized using a mechanical grinder and the flour was sieved at 200 mesh passage. A common basic recipe was used to prepare the cupcakes by changing the percentage of durian seed flour. A sensory evaluation was carried out to select the most acceptable cupcake among egg cupcake and vegan cupcake produced by durian seed flour evaluating taste, color, texture, aroma and overall acceptability of the samples. The sensory data were analyzed by Kruskal Wallis one-way non parametric ANOVA using the computer software package STATIX (Ver 10).

The most acceptable sample was tested for proximate analysis (total ash content, fat content, fiber content, crude protein content), and moisture content. Shelf life of the product was determined by microbiological analysis evaluating total plate counts, and yeast and mold count. Quality of the cupcakes was tested for the shelf life during storage for 4 weeks. Total ash content of the developed product was determined using muffle furnace and fat content was determined using soxhlet extraction apparatus, fiber content was determined according to the enzyme modified neutral detergent fiber method and protein content was determined using Kjeldahl method. Every analysis was in accordance with the procedures described by the Association of Official Analytical Chemists (2007) and Pearson (1968).

Results and Discussion

According to the Table 1, sample B is significantly different from sample A and C ($p < 0.05$) and there is not a significant different between the sample A and C. Sample B shows the highest mean rank value for the texture, taste, aroma, color, appearance in the statistical analysis. Sample B shows the highest mean rank value for the statistics analysis of the sensory properties. Sample B and C where the more durian flour were added is having the higher values while the sample B was the best sample for the sensory properties.

Table 1. Sensory results (mean ranks) from three types of cakes

Sample	Texture	Taste	Aroma	Color	Appearance	Overall acceptability
Sample A	36.67[b]	33.83[b]	44.44[a]	38.11[b]	40.00[b]	32.02[b]
Sample B	63.75[a]	58.98[a]	52.08[a]	56.55[a]	59.75[a]	62.08[a]
Sample C	45.08[b]	52.69[a]	48.98[a]	50.84[b]	45.75[ab]	51.41[a]

Sample A –cupcake which is incorporated 3.6% durian flour
Sample B – cupcake which is incorporated 4.8% durian flour
Sample C – cupcake which is incorporated 6% durian flour

According to the above sensory data following recipe found to be the best.

Table 2.Best recipe (sample 2) and of durian seed cupcake compared to the egg cupcake

Ingredients	Durian cupcake	Egg cupcake
Wheat flour	0.125 kg	0.125 kg
Margarine	0.125 kg	0.125 kg
Sugar	0.090 kg	0.125 kg
Eggs	-	2
Durian flour	0.012 kg	-
Baking powder	0.003 kg	0.003 kg

The following table shows the observed results of the chemical analysis

Table 3. Results for the proximate composition for durian seed flour and the cupcakes

Nutrient factor (%)	Durian flour	Commercial cupcake (egg cupcake)	Durian seed flour cupcake
Moisture	10.2%	25.90%	17.2%
Carbohydrates	72.6%	56.68%	73.68%
Protein	7.6%	7.9%	1.4%
Fat	0.4%	7.42%	5.23%
Fiber	5.1%	1.2%	1.49%
Ash	4.1%	0.9%	1.0%

When considering the protein content of the durian flour cupcake and egg cupcake egg cupcake has a higher content of protein (7.9%) than the durian flour cupcake (1.4%) as it has been incorporated with chicken eggs. when it comes to the fat content of the two cupcakes durian cupcake has a low fat content (5.23%) than the egg cupcake (7.42%). Therefore durian flour cupcake can be used as a substitution for the egg cupcake and it may drive to have a healthy life as it contains a low fat content.
Total plate count values for the initial, 3 days and 6 days are 0.035×10^6, 0.098×10^6 and 3.1×10^6 respectively. Yeast and mold count values for the initial, 3 days and 6 days are

0.034×10^6, 0.094×10^6 and 2.04×10^6 respectively. The values for the initial and 3 days were in the safe range (1×10^6) and the value for the 6 days was in out of the range for both total plate counts and yeast and mold counts.

The sensory analysis between egg cup cake and vegan cup cake, it showed all the sensory attributes for egg cupcake has higher mean rank values, however, there is not a significant difference between the two samples except aroma. Overall acceptability of the two samples also does not show a significant difference. It was used an egg cupcake to compare the best formulation of the vegan cupcake. However the vegetarians are able to add durian flour cupcake to their diet instead of the egg cupcake as the egg cupcakes even though it shows better sensory attributes that cannot satisfy the desire of the vegetarian people as it contains eggs.

The cost reduction percentage of vegan cupcake compared to the egg cupcake was 21.38 %

Conclusion

The durian seed gum could be used as an emulsifier for making vegan cupcakes (no eggs), because it produced fairly stable emulsion and good texture. Based on the sensory results, it was selected the best vegan cupcake with addition of 4.8% durian seed flour concentration, and paired comparison test results showed that there is not a significant difference between the durian seed flour cupcake and the egg cupcake. Thus, the seeds of durian are not just a waste any more, but could be used as emulsifiers in making of vegan cupcakes.

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ESTABLISHMENT OF PROCESSING PARAMETERS FOR THE DEVELOPMENT OF A SNACK FROM SWEET POTATO

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Summary

Processing parameters were established for developing a snack from sweet potato. Effect of hot water and steam blanching was studied and steam blanching was suitable for the product. Steam blanched slices were heated at 75±5^{O}C for 40 min. in sugar syrups (40, 50 and 60^{o}Brix), 10 % glycerin and 0.2 % citric acid. There slices heated in 50 ^{O}Brix sugar syrup were preferred by panelists. Dehydration of slices at 55 ^{O}C for 4 h reduced the moisture content (MC) from 64.2±0.3 to 11.5±0.5 % and water activity (a_w) from 0.643±0.038 to 0.182±0.004. Titratable acidity (TA), pH, total soluble solid (TSS), reducing sugar (RS) and total sugar (TS) contents of the fresh and dehydrated slices were 0.07 ± 0.00 and 0.08 ± 0.00%, 6.07±0.04 and 4.67±0.03, 6.5±0.3 and 11.8±0.4 ^{O}Brix, 6.96 ± 0.12 and 22.27±0.58% and 12.05 ± 0.17 and 34.53±1.71%, respectively. Consumers were moderately preferred the product. Therefore, steam blanching of slices for 15 min followed by heating in 50 ^{O}Brix sugar syrup containing 10% glycerin, 0.2% citric acid for 40 min. and dehydrating at 55^{O}C for 4 h can be recommended for producing a snack.

Keywords: Sweet potato, Blanching, Glycerin

Introduction

Sweet potato is consider as an under exploited food crop. Therefore expansion in research and development helps to transform sweet potato to an important commercial crop with multiple uses such as a snack, ingredient in various foods and complementary vegetable. According to reports snack products plays an important part in daily diet of consumers. Most of snacks are high in salt and fat contents. Consumers are demanding on more nutritious and healthier snacks, because of that there is a higher potential to develop healthier snacks from sweet potato.

Through this research, processing parameters for a dehydrated snack were established for sweet potato. There few problems were addressed during the development process as hard texture of slices after dehydration, browning of slices and quick mold growth on dehydrated slices. Slices were pretreated with NaCl and Citric acid and blanched to preserve the color of slices. Steam blanching and hot water blanching were experimentally tested. The shelf life food depends on its water content and water absorption capacity of a product depends on the hygroscopic components water affinity

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(Sablani *et al.,* 2007). The lower water activity can be infused by sugars and humectants such as glycerin (Agarwala, 1985) and it helps to extend the shelf life of the product.

Methodology

Wariyapola Red tubers, with 17.8 cm of average mid circumference, 63.5% average MC and TSS level around 7 o Brix were cleaned and sliced to vertical slices having 6 ± 1 mm thicknesses. Then slices were pretreated by immersed in 0.2% NaCl , 0.4% Citric acid solution at 27 ± 2^{O}C for 15 min. Steam blanching and hot water blanching at 100 ±10^{O}C for 10 min. were tested to select suitable blanching method. Slices were heated at 70 – 80 oC temperature range in 60 o brix sugar syrup containing 10% glycerin, 0.2% citric acid for 40 min. Then slices were dried in a tray drier at 55 ^{O}C until MC of slices was around 14±2%. Sugar syrup treatment was done at three levels as 40, 50 and 60 ^{O}Brix. Final snack was produced by steam blanching pretreated slices for 15 min. and treated with 50o brix sugar syrup. Slices were dried in a tray drier (H190303, ST-60 MA, Leader, Japan) at 55^{O}C until the MC of slices were 14±2%. Packaging methods were tested on Nylon / LLDPE packaging material. MC was measured by moisture analyzer. (SNR 1128123623, OHAUS, Switzerland). aw was measured by a water activity meter (MS 1, Novasina, Japan) and pH was measured by a digital pH meter (S-40801, HANNA, Japan). TA tested according to AOAC method. TSS measured by a digital hand refractometer (3831, ATAGO, Japan). RS and TS were measured according to Lane and Eynone method. Total plate count, yeast and mold tests were done according to SLS 516; 1991. Paired preference tests, ranking test and consumer sensory analysis were performed. Statistical analyses were performed by Minitab.v17.1.0 (Minitab Inc., LEAD Technologies, U.S.A).

Results and Discussion

Blanching improves appearance and color of dehydrated slices. Longer blanching time can reduce initial moisture level to lower level with compare to short blanching time (Hatamipour *et al*., 2007). When comparing hot water blanching and steam blanching, final MC of hot water blanched dried slices were lower than steam blanched slices.

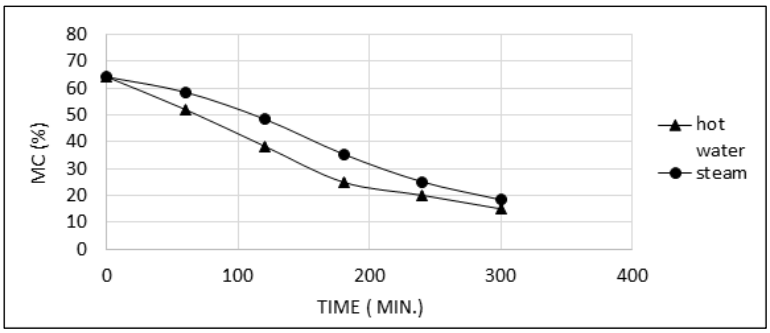

Figure 01: Effect of hot water blanching and steam blanching on the MC of sweet potato slices during dehydration at 550C for 5 hours.

Drying rate of hot water blanched slices also higher than steam blanched slices. But when compare sensory properties of steam blanched slices, preference on appearance, texture and sweetness are higher than hot water blanched slices. Conventionally dehydrated fruit pieces have higher MC and hard texture, which leads to lower consumer preference. As reported in a United States patent, osmotic treatment of sugars- acids-polyols combine treatment can improve the texture and self-life of dried fruit pieces. There dried fruit pieces can achieve soft texture at lower a_w. This processing method is mostly preferred for fruits and vegetables with higher pectin content (Agarwala, O.P., 1985). Heating the slices at 70 – 80^{O}C for 40 min. in 50 o brix sugar syrup containing 10% glycerin, 0.2% citric acid was effective in improving the sensory properties and keeping quality of the snack.

Table 01: Sensory evaluation average rank totals of SB10, SB15 and SB20

	Texture [A]	**Sweetness** [B]
SB_{10}	2.30 [a]	2.30 [a]
SB_{15}	2.27 [a]	2.37 [a]
SB_{20}	1.43 [b]	1.33 [b]

Table 02: Sensory evaluation average rank totals of B40, B50 and B60

	Texture [A]	**Sweetness** [B]	**Overall acceptability** [C]
B_{40}	2.03[a]	1.97[a]	2.00[a]
B_{50}	2.33[a]	2.33[a]	2.33[a]
B_{60}	1.63[b]	1.70[b]	1.67[b]

3= most preferred, 2= preferred and 1= least preferred.

The storage study was conducted for one month period and the study should be continuing for snack product to determine the actual shelf life of the final product. In Japan, sweet potatoes were processed in to various food products. By comparing the final product with a similar product from Japanese market will support in further developments of the snack product. Color of snack can be further developing, because color of the snack received comparatively less score with compare to other properties.

Table 03: Effect of storage on MC, aw and microbiological properties of dehydrated slices

Storage time (weeks) at Room Temperature	**MC (%)**	**a_w**	**Total plate count (cfu/g)**	**Yeast & Mold count (cfu/g)**
0	11.45±0.50	0.182±0.004	< 10	Nil
4	12.74±0.77	0.180±0.000	< 20	< 20

Conclusion

Steam blanching for 15 min. is suitable for snack processing than hot water blanching as revealed by sensory properties. By 50 o brix sugar syrup treatment the sensory properties and keeping quality of the snack improves. According to storage study for one month, vacuum packaging in Nylon/LLDPE bags with an oxygen scavenger was an effective packaging method in ambient conditions. The snack received a score of 7.42 ± 1.02 indicating that the panelists moderately liked the snack.

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