International Journal of Academic and Applied Research (IJAAR)
ISSN: 2000-005X
Vol. 2 Issue 8, August – 2018, Pages: 18-26

Food Preservative Characteristics of Dehydrated Murunga (*Moringa Oleifera*) Leaf Powder

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Abstract: *Murunga (Moringa oleifera)* ***is an underutilized plant in Sri Lanka with food, nutritional and medicinal value.*** *This study was carried out to evaluate the food preservative characteristics of dehydrated Murunga leaf powder. Soya meat (textured soy protein) and Dhal curries (cooked) and boiled rice (Suwandel variety and red rice) treated with different levels of Murunga leaf powder (1.5, 2.5, 4.5 and 6%) were selected for this experiment. Sensory evaluation was conducted with the help of 30 untrained panelists using a five point hedonic scale in order to identify the acceptable level of Murunga leaf powder in these foods. Protein content (Kjeldahl method) and pH (using a pH meter) of these food samples in each experiment were determined just after cooking and after 24 hours. Microbial counts and sensory acceptability of the product were determined in eight hours interval in ambient conditions. Significant differences (P<0.05) were observed in the reduction of protein content and increase of pH of above cooked meals with Murunga leaf powder when compared with the control at the end of storage period. There were significant differences (P<0.05) in the total plate counts in all cooked food samples with Murunga leaf powder when compared to the control. However, no coliform counts were reported for any of the food samples. After 16 hours, colour, flavour, odor and overall acceptability of Murunga leaf powder treated food samples were significantly different (P<0.05) compared to the control samples. This study revealed that the dehydrated Murunga leaf powder could be potentially used to extent the shelf life of cooked food products such as rice and curry.*

Keywords: preservative, food, Murunga leaf powder, shelf life

1. INTRODUCTION

Food is essential for the survival of human. Food preservation is one of the oldest technologies used by human to avoid the food spoilage. With the increase of human population, the demand for the food was also increased and the efficient food preservative methods were used to preserve the foods.

Around 25% of whole food produced is lost post-harvest owing to microbial activity so Microbial spoilage of food is a big problem among food producers. In domestic situation less shelf life of cooked meals is waste of money and time (Baird-Parker, 2003). Several chemicals are used to preserve foods in these days such as benzoates, sodium benzoate, sorbate, nitrate, sulfer, vitaminE, vitamin and butyrate hydroxytoluene. Most of the commercially available preservatives could change the food structure and they may become harmful for the body when continuous consumption with food (Annon,2010).

High cost for food preservation is increased the price of food and become burden to the life. Artificial food preservatives are having no or low nutritive value, so essential of natural preservatives is highly realized in these days. When plant originated compounds use as preservative, they are beneficial to the body and locally available resources also utilized. Moringa(*Moringa oleifera*) leaves have evidences to use as food preservative. Murunga leaves are rich sources of the protease inhibitor and effective way to extend the shelf life of seafood (Bijina, et al., 2011).

Objectives

- To produce Murunga leaf powder as an effective food preservative when incorporated into selected meals.
- To find out the acceptable amount of Murunga leaf powder to preserve the specific food
- To evaluate the organoleptic properties of foods after adding Moringa leaf powder

2. MATERIALS AND METHODS

Location

This study was carried out at Food Laboratory, Institute of Post-Harvest Technology, JayanthiMawatha, Anuradhapura. Leaves were picked from the farm of the Institute of Post-Harvest Technology. Rice, Dhal, Soya meat and other ingredients was purchased from market.

Preliminary Studies

Preliminary studies were carried out to find acceptable amount of dehydrated Murunga leaves powder incorporate with certain food. The amount of Murunga leaves powder was changed while keeping other ingredients constant in each experiment as shown in the table 1

Table 1: Composition of Preliminary recipes as (%)

Experiments (100 g of meal)	*Treatments (Dehydrated Murunga leaf powder)*				
	control	T_1	T_2	T_3	T_4
1.Cooked parboiled rice (Suwandel)	0g	1.5g	2.5g	4.5g	6g
2. Cooked red rice	0g	1.5g	2.5g	4.5g	6g
3.Soya curry	0g	1.5g	2.5g	4.5g	6g
4. Dhal curry	0g	1.5g	2.5g	4.5g	6g

Every treatment was having three replicates. The ordinary Sensory evaluation test was conducted to find out the best treatment in each experiment and the selected treatment was further developed. The Sensory panel was consisting with 30 untrained panelists from the IPHT and odor, color, flavor, texture and overall acceptability of the food was evaluated.

Preparation of foods

Cooking rice

MITSHU automatic rice cooker was used to cook the rice. Suwandel parboiled rice or red rice was weighted and placed in the pan by using rice cooker measuring cup. Three to four cups of water was added per each cup of rice. Lid was closed and rice cooker was turned on. After 10 minutes properly weighted dehydrated morning leave powder was added and mixed well. After another 10 minutes rice became ready.

Preparation of Dhal curry

The lentil was washed & placed in a medium size saucepan. Then all the ingredients were added for the curry, except coconut milk and dehydrated Murunga leaves powder. Mixed well and, kept in on medium heat to boil the lentils. When the lentils were boiled, coconut milk was added and bought it to boil again and tasted to salt. The cooked curry was weighted and 3 gram of dehydrated morning leave powder was added for each 100grme of curry. Dehydrated morning leave powder incorporated curry was mixed well and re heated for two minutes. Finally the curry was serve to sensory evaluation and filled in Polypropylene cups for further tastings.

Preparation of Soya meat curry

Soya meat was heated initially with water and after removal of water sliced in to small pieces. Soya met pieces were placed in a medium size saucepan. Then all the ingredients were added for the curry, except coconut milk and dehydrated Murunga leaves powder. Mixed well and, kept in on medium heat.

When the curry was boiled, coconut milk was added and bought it to boil again and tasted to salt. The cooked curry was weighted and 3 grams of dehydrated morning leave powder was added for each 100gram of curry. Dehydrated morning leave powder incorporated curry was mixed well and reheated for two minutes. Finally, the curry was serve to sensory evaluation and filled in Polypropylene cups for further tasting.

Sensory evaluation

A sensory evaluation was carried out to find out the best treatment out of all four preliminary treatments and it was used in further development. Sensory panel consisting 20 untrained panelists from the Institute of Post-Harvest Technology. The color, odor, texture, flavor, mouth feel was evaluated using a five-point hedonic scale.

Physiochemical Analysis of the cook food

The selected recipe was prepared and stored in ambient condition for 24h period. Tree replicates were prepared per each treatment, protein content, pH, microbial quality were measured at initial stage and after 24 hours. Sensory quality was measured in 8 hour interval form initial to 24 hours. A control is always prepared and tested with treatment parallel.

Determination of pH

pH value of the food was tested using the electronic pH meter (Model 230A+).

Microbiological study

Total plate count and Coli form count of the selected product were tested according to the method described in the Essentials of Food Microbiology (Garbatt, 1977)

Total plate count

Pour plate method was used. Preparation of the test sample, initial suspension and further decimal dilution were done according to Essentials of Food

Microbiology by Garbutt (1977). Using sterilized pipettes 1 ml of each dilution was transferred in to sterilized Petri dishes, when the medium solidify. Finally those plates were kept in incubator at 30 ^{0}C for 72 hours.

Total Coli form Count

Spread plate method was used. Preparation of the test sample, initial suspension and further dilution were done according to Essentials of Food Microbiology by Garbutt (1997). Using sterilized pipettes 1 ml of each dilution was transferred in to sterilized Petri dishes. When the MacConky agar medium solidifies. Finally, plates were kept in incubator at 36 ^{0}C for 24 hours.

Shelf life Evaluation

A sensory evaluation was carried out to find out the best treatment which has long shelf life out of all four treatments. Sensory panel consisting 30 untrained panelists from the Institute of Post-Harvest Technology. The smell, color, taste and texture were evaluated using a five point Hedonic scale.

Data Analysis

Data of the sensory Evaluation was tested using non parametric Friedman Test with Statistical software Minitab
Data of physiochemical study was tested using Complete Randomized Design in Factorial Experiments in (SAS).

3. Results and Discussion

Results of the preliminary test

Totally 4 treatments were prepared in each experiment during preliminary study and the best treatment was selected using sum of ranks of sensory evaluation(Extremely like=5 and extremely dislike=1). According to sum of ranks of sensory evaluation, acceptability of the treatment number 3 (4.5g Leaf powder /100g of cooked meal) was higher comparing with other three treatments, it was selected as a best treatment.

According to sum of ranks of sensory evaluation, acceptability of the treatment number 2 (2.5g Leaf powder /100g of cooked meal) was higher comparing with other three treatments, it was selected as a best treatment. According to sum of ranks of sensory evaluation, acceptability of the treatment number 3 (4.5g Leaf powder /100g of cooked meal) was higher comparing with other three treatments, it was selected as a best treatment. According to sum of ranks of sensory evaluation, acceptability of the treatment number 3 (4.5g Leaf powder /100g of cooked meal) was higher comparing with other three treatments, it was selected as a best treatment.

Chemical Analysis

Chemical analysis was done just after the cooking and after 24 hours to selected treatment and control in every experiment. Values obtained from chemical analysis and found that, there were no significant changes in protein content of Suwandel cooked rice and cooked red rice but slight changes in the protein content of Soya curry and Dhal curry. Less reduction of protein content in selected treatments of Dhal curry and Soya meat curry, when compare with reduction of protein content in control after 24 hours

When compare with control less reduction in pH in the selected treatment of Soya meat curry, Dhal curry and Suwandel cooked rice was observed. Thus, it seems likely that Murunga leaf powder has some effect on pH reduction.

Microbial load

Total plate count

Table 2 : Variation of the total plate count of the treatment and control in 8 hours interval

Experiment	Just after		8 hours		16hours		24hours	
	Control	treatment	Control	treatment	Control	treatment	Control	Treatment
E_1	$0.18*10^2$	$0.17*10^2$	$0.47*10^2$	$0.29*10^2$	$2.61*10^2$	$1.31*10^2$	$4.93*10^2$	$2.81*10^2$
E_2	$0.17*10^2$	$0.14*10^2$	$0.32*10^2$	$0.37*10^2$	$2.06*10^2$	$1.1*10^2$	$5.16*10^2$	$2.92*10^2$
E_3	$0.15*10^2$	$0.16*10^2$	$0.65*10^2$	$0.23*10^2$	$3.18*10^2$	$0.9*10^2$	$4.35*10^2$	$2.18*10^2$
E_4	$0.18*10^2$	$0.17*10^2$	$0.47*10^2$	$0.31*10^2$	$2.67*10^2$	$1.01*10^2$	$5.15*10^2$	$4.8*10^2$

E_1.Soya meat curry, E_2- Dhal curry, E_3- Suwandel cooked rice, E_4- Cooked red rice

There were significant differences in the total plat count of treatments compared to control in all four experiments. During the storage time total plate count was increased but when compare with control total plate count of selected treatment was increased in a decreasing rate, so dehydrated Murunga leaf powder may have some effect on reducing of microorganisms.

Coli-forms count

Coli-forms were absent in all experiment.

Sensory evaluation

Sensory evaluation of Soya meat curry

Selected treatment of Soya meat curry (4.5g Leaf powder /100g of cooked meal) was used for the sensory analysis in 8 hours intervals. According to results of the tasting panel estimated hedonic medians tabulated below

Table 3 : Estimated hedonic median for each organoleptic characters of selected treatment of Soya curry

	Color	Appearance	Flavor	Odor	Overall acceptability
Just cooked	1.50	1.20	1.25	1.50	1.75
After 8hr	2.00	2.75	1.50	2.00	2.00
After 16hr	2.75	3.50	3.75	3.25	3.50
After 24hr	4.50	4.75	-	5.00	5.00

P value	0.223	0.009	0.962	0.021	0.034
Grand median	2.69	2.80	2.17	2.94	3.06

Probability values of organoleptic characters of selected treatment of Soya curry showed that there were significant differences based on the time intervals. Probability values of color and flavor were 0.223 and 0.962 respectively. These values were greater than 0.05 which imply there were no any significant differences in color and appearance with time.

P values of appearance (0.009), odor (0.021) and overall acceptability (0.034) were less than 0.05, which imply presents of significant different among interval.

According to ballot sheet highest rank (1) is given to extremely like phrase and lowest rank (5) is given to extremely dislike phrase (Appendix 2). Other phrases are in between.

Comparison organoleptic characteristics of Soya meat curry with control

Selected treatment of Soya meat curry (4.5g Leaf powder /100g of cooked meal) was compared with control for organoleptic characteristics in 8 hours interval in ambient condition. Sums of rank and hedonic median of both foods results are given below

P value of flavor, appearance and overall acceptability were greater than 0.05. P value of color (0.032) and odor (0.047) are less than 0.05 which mean odor and color of the selected treatment of Soya meat curry had significant differences comparedto control just after cooking.

P value of appearance, odor and overall acceptability were greater than 0.05. P value of color (0.042) and flavor (0.038) are less than 0.05 which mean color and flavor of the selected treatment of Soya meat curry had significant differences compared to control after 8 hours.

Table 4: hedonic median of control and selected treatment of Soya meat curry, after 16 hours

	Color	**Appearance**	**Flavor**	**Odor**	**Overall acceptability**
Selected treatment	2.75	3.50	3.75	3.25	3.50
Control	3.75	3.25	4.75	4.75	3.25
P value	0.732	1.725	0.047	0.032	0.033
Grand median	3.25	3.38	4.25	4.00	3.37

P value of Appearance and color were greater than 0.05 and there were no significant difference.P value of flavor (0.047),odor (0.032) and overall acceptability (0.033) were less than 0.05 which mean odor, flavor and overall acceptability had significant differences in selected treatment of Soya meat curry compared to control after16 hours.

P values of color, appearance, odor and overall acceptability were greater than 0.05.There were no significant differences in organoleptic characters of selected treatment of Soya meat curry compared to control after24 hours. Flavor was not evaluated after 24 hours because food was severely spoiled after 24 hours

Graph 4.1: Comparison of organoleptic characters of Soya meat curry with control

Sensory evaluation of cooked red rice

Selected treatment of cooked red rice (4.5g Leaf powder /100g of cooked meal) was used for the sensory analysis in 8 hours intervals. According to results of the tasting panel estimated hedonic medians tabulated below

Probability values of organoleptic characters of selected treatment of cooked red rice showed that there were

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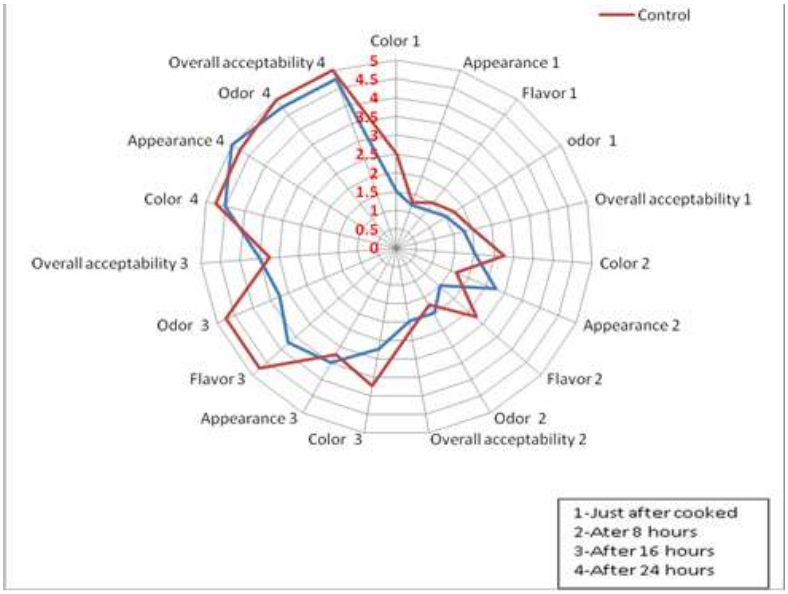
ISSN: 2000-005X
Vol. 2 Issue 8, August – 2018, Pages: 18-26



significant differences present among time intervals. Probability values of color (1.761) is greater than 0.05 which imply there was no any significant different in color with time.

P values of appearance (0.035), flavor (0.002) odor (0.011) and overall acceptability (0.014) were less than 0.05, which imply there were significant differences among organoleptic characters of dehydrated Murunga leaf powder treated cooked red rice.

Comparison of organoleptic characters of cooked red rice with control

Selected treatment of cooked red rice (4.5g Leaf powder /100g of cooked meal) was compared with control for organoleptic characters in 8 hours interval in ambient condition. Sums of rank and hedonic median of both foods results are given below

Table 5: Hedonic median of control and selected treatment of cooked red rice just after cooking.

	Color	Appearance	Flavor	Odor	Overall acceptability
Selected treatment	1.00	1.50	1.25	3.25	1.75
Control	2.00	1.50	1.50	1.00	2.00
P value	0.044	0.925	4.262	0.035	0.632
Grand median	1.5	1.5	1.37	2.12	1.83

P value of flavor, appearance and overall acceptability were greater than 0.05.P value of color (0.044) and odor (0.035) were less than 0.05 which mean color and odor of the selected treatment of cooked red rice had significant differences compared to control just after cooking.

Table 6: Hedonic median of control and selected treatment of cooked red rice after 8 hours.

	Color	Appearance	Flavor	Odor	Overall acceptability
Selected treatment	2.00	1.50	2.50	3.00	2.00
Control	3.00	1.50	2.50	1.75	2.00
P value	0.048	2.97	0.031	0.701	0.433
Grand median	2.50	1.50	2.00	2.35	2.00

P value of appearance, odor and overall acceptability are greater than 0.05. P value of color (0.048) and flavor (0.031) were less than 0.05, which mean color and flavor of the selected treatment of the cooked red rice had significant differences compared to control after 8 hours.

Table 7: Hedonic median of control and selected treatment of cooked red rice, after 16 hours.

	Color	Appearance	Flavor	Odor	Overall acceptability
Selected treatment	2.50	2.25	2.75	3.50	2.25
Control	3.50	2.00	3.50	4.50	3.75
P value	0.037	4.525	0.026	0.041	0.028
Grand median	3.00	2.13	3.25	4.00	3.00

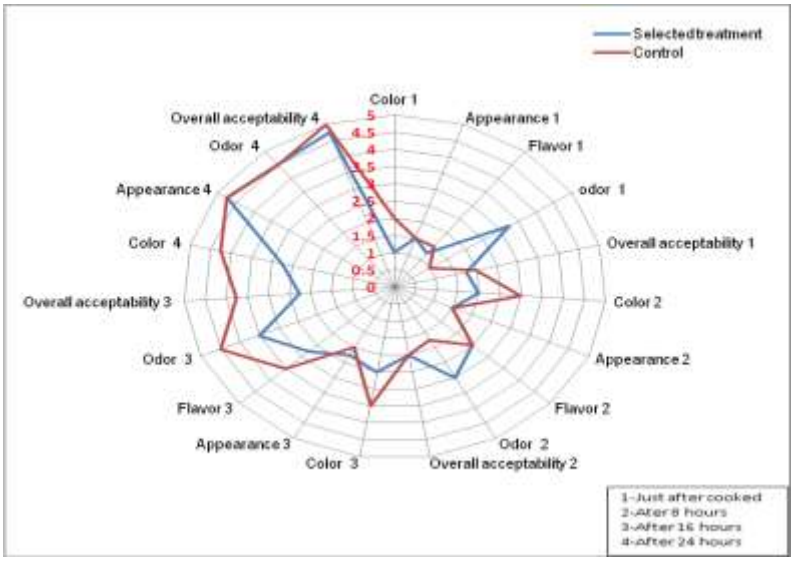
P value of appearance is greater than 0.05 and there was no significant different. P value of color (0.037), flavor (0.026) odor (0.041) and overall acceptability (0.028) were less than 0.05 which mean color, flavor, odor and overall acceptability had significant differences in selected treatment of cooked red rice compared to control after 16 hours.

Table 8: Hedonic median of control and selected treatment of cooked red rice after 24 hours.

	Color	Appearance	Odor	Overall acceptability
Selected treatment	2.75	4.75	4.50	4.75
Control	4.25	4.75	4.50	5.00
P value	1.532	2.025	2..23	4.607
Grand median	3.50	4.75	4.50	4.63

P values of color, appearance, odor and overall acceptability were greater than 0.05. There were no significant differences in organoleptic characters of selected treatment of cooked red rice compared to control after24 hours. Flavor was not evaluated after 24 hours because food was severely spoiled after 24 hours.

Comparison of organoleptic characters of selected treatments with control was done for Suwandel parboiled rice and the results were as same as cooked red rice.



Graph 2: Comparison of organoleptic characters of cooked red rice with control

Sensory evaluation of Dhal curry

Selected treatment of Dhal curry (2.5g Leaf powder /100g of cooked meal) was used for the sensory analysis in 8 hours intervals. According to results of the tasting panel estimated hedonic medians tabulated below

Table 9: Estimated hedonic median for each organoleptic characters of selected treatment of Dhal curry

	Color	Appearance	Flavor	Odor	Overall acceptability
Just cooked	3.00	2.00	1.00	3.50	2.00
After 8hr	2.75	2.50	2.00	2.50	2.25
After 16hr	3.75	2.25	3.00	3.50	2.75
After 24hr	3.50	4.50	-	4.75	4.75
P value	2.081	0.046	0.029	0.004	0.038
Grand median	3.25	2.81	2.00	3.56	2.93

Probability values of organoleptic characters of selected treatment of Dhal curry showed that there were significant differences present among time intervals. Probability values of color (2.081) was greater than 0.05 which imply no any significant different in color chance during time.

P values of appearance (0.046), flavor (0.029), odor (0.004) and overall acceptability (0.038) were less than 0.05, which imply there were significant differences among organoleptic characters of dehydrated Murunga leaf powder treated Dhal curry during the storage time.

Comparison of organoleptic characters of Dhal curry with control

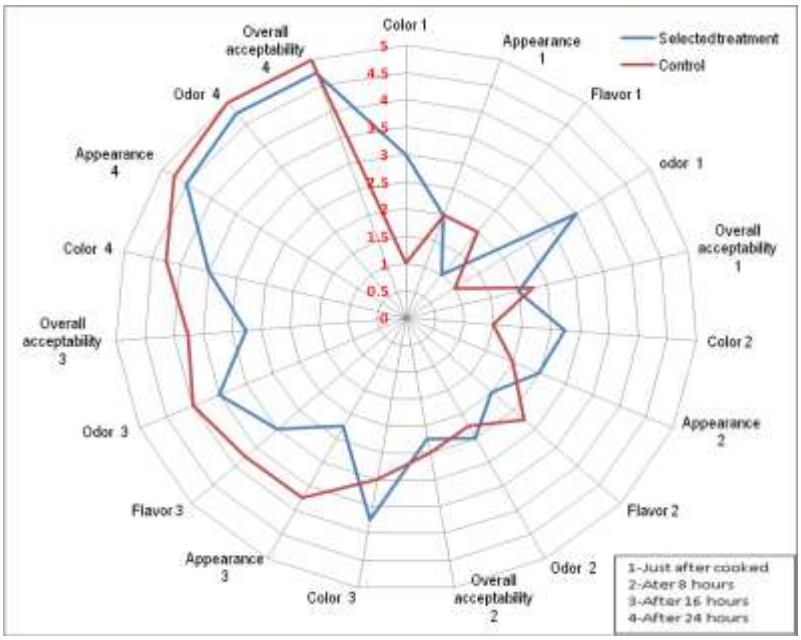
Selected treatment of Dhal curry (2.5g Leaf powder /100g of cooked meal) was compared with control for organoleptic characters in 8 hours interval in ambient condition. Sums of rank and hedonic median of both foods results are given below

P value of appearance and overall acceptability are greater than 0.05. P value of color (0.008), odor (0.017) and flavor (0.041) were less than 0.05 which means flavor, color and odor of the selected treatment of Dhal curry had significant differences compared to control just after cooking.

P value of appearance, odor and overall acceptability are greater than 0.05. P value of color (0.014) and flavor (0.025) were less than 0.05, which mean color and flavor of the selected treatment of the Dhal curry had significant differences compared to control after 8 hours.

P value of flavor was greater than 0.05 and there was no significant different. P value of color (0.022), appearance (0.006), odor (0.009) and overall acceptability (0.041) were less than 0.05 which mean color, appearance, odor and overall acceptability had significant differences in

P values of color, appearance, odor and overall acceptability were greater than 0.05. There were no significant differences in organoleptic characters of selected treatment of Dhal curry compared to control after24 hours. Flavor was not evaluated after 24 hours because food was severely spoiled after 24 hours.



Graph 3: Comparison of organoleptic characters of Dhal curry with control

According to above analysis of organoleptic characters of control and selected treatment, it can be concluded that the dehydrated Murunga leaf powder may alter some organoleptic properties. Color, flavor, appearance, odor and overall acceptability were improved in dehydrated Murunga leaf powder treated food compared to the control.A Previous study was proved that fresh Murunga leaf juice have antimicrobial properties and inhibit the growth microorganism especially *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Abalaka, et al., 2012).Total plate count of this study also showed that there were some significant reduction of microorganisms in dehydrated Murunga leaf powder treated food compared to the control with time. It means Spoilage of the dehydrated Murunga leaf powder treated food was slower than the control.

This study was carried out for selected cooked meals but some researchers showed that Murunga leaves extract isrich source of the protease inhibitor such as trypsin and chymotrypsin and thereby it can be used as an effective way to extend the shelf life of seafood (Bijina, et al., 2011).

However through these results we can conclude that dehydrated Murunga leaf powder could potentially improve the shelf life of the foods and it may be as a food preservative. Organoleptic characters such as color, flavor and appearance are favorable when Dehydrated Murunga leaf powder incorporated in the food, but the leafy odor of the dehydrated Muruga leaf powder somewhat unfavorable, it may be corrected by adding some odor improving additives such as Curry leave **(***Murrayakoenigii)*, Rambai leaves (*Baccaureamotleyana*),Cardomom,Turmeric, Cinnamon, Clove, ect. It is essential to Fine tune this study to evaluate the food preservative characteristics of Murunga leaves with various food types.

4. CONCLUSIONS

Dehydrated Muruga leaf powder have some effects on increasing shelf life of selected cooked food products such as Dhal curry, Soya meat curry and Cooked rice. Therefore Dehydrated Muruga leaf powder can be used as food preservative.

The amount of 2.5-3 grams of dehydrated Muruga leaf powder per 100 grams can be considered as the acceptable amount when cooking curries like Soya meat and Dhal.4.5-5 grams of dehydrated Muruga leaf powder per 100 grams can be considered as the acceptable amount when cooking rice.

REFERENCES

[1] Abalaka., M.E. Daniyan., S. B. Oyeleke., S. O and Adeyemo ,P.A, (2012).The Antibacterial Evaluation of Moringa Oleifera Leaf Extracts on Selected Bacterial Pathogens ,Journal of Microbiology Research,1-4pp.

[2] A.K. Smith and S.J. Circle (1972).Chemistry and Technology, Soybeans, The AVI Publishing Company, page 442, [online] [Accessed on 06.07.2012], Available at http://en.wikipedia.org/wiki/Soyabean

[3] Annon (2009),Dhal, [online] [Accessed on 03.07.2012],Available at, http://en.wikipedia.org/wiki/Dhal

[4] Annon (2010), Artificial preservative, [online] [Accessed on 20.07.2012],Available at, http://en.wikipedia.org/wiki/preservative

[5] Annon(2011),moringa,[online][Accessed on 03.05.2012], Available at, http://en.wikipedia.org/wiki/Moringaoleifera

[6] Annon,(2002),HDRA,organicorganisation, The Tropical Advisory Servicemulti-purpose trees,[online] [Accessed on 05.05.2012], Available at, http:\\www.hdra.org.uk /cv8/ 3LG/html.

[7] Baird-Parker, T.C, (2003), The Microbiological Safety and Quality of Food,Aspen Publishers Inc., pp. 3–18.

[8] Bijina,B.,SreejaChellappan, Jissa .Krishna.G, Soorej ,Basheer.M ,Elyas, K.K.,Ali., Bahkali ,H.,Chandrasekaran.M,(2011).Protease inhibitor from Moringa oleifera with potential for use as therapeutic drug and as seafood preservative, Saudi Journal of Biological Sciences , 18, 273–281, [online] [Accessed on 06.05.2012], Available at, http:\\www.ksu.edu.sa

[9] David Kilcast and subramaniam,P.(2004) The stability and shelf-life of food CRC press,1-80 pp

[10] Garbatt,(1977) ,Essentials of Food Microbiology,65-70pp

[11] Heid,j.l,(1967) fundamental of food processing operation,Eng direction new product development ,trivalleg growers sanjose,California,104-05pp.

[12] Heldman,D.R and hartel,R.W (1998).principles of food processing,Aspen Publisher,34-177pp.

[13] National research council (2006).”Moringa” lost crops of Africa, National academic press, 247pp.

[14] Owen R Fennema, MarcelDekkar, (1975). Nutritional, therapeutic and prophylactic properties, Retrivedjanuarey principles of food science, 309-400-409pp.

[15] Perera,S.(2011) the world’s wonderful day tree in Asia,lanka,deepa,srilanka,Sunday.

[16] Ramachandran,C.Peter,K.V and Gopalkrishnan, P.K(1987). Drumstick (Moringa oleifera) A multi purpose Indian Vegetable,Economicbotany,New York Botanical Garden- Bronx,NY,34.

[17] Yapa, P.A. (2000).text book of “Murunga”,tharanga publidhers,54-55pp.