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Preface

We would like to present, with great pleasure, the inaugural volume-3, Issue-6, June 2017, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas

Environmental Research:

Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

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Agricultural Sciences	
Soil Science	Plant Science
Animal Science	Agricultural Economics
Agricultural Chemistry	Basic biology concepts
Sustainable Natural Resource Utilisation	Management of the Environment
Agricultural Management Practices	Agricultural Technology
Natural Resources	Basic Horticulture
Food System	Irrigation and water management
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Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
Pulse Crops: Peas (all types), field beans, faba beans, lentils, soybeans, peanuts and chickpeas.	Hay and Silage (Forage crop) Production
Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
Tree Nut crops: Hazlenuts. walnuts, almonds, cashews, pecans	Berry crops: strawberries, blueberries, raspberries
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Assessment of Post-Harvest Loss and Waste for Date Palms in the Kingdom of Saudi Arabia

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Abstract— *Estimated dates loss at harvest time include shees & besr, eating by birds, falling, insects and dust mite, and healthy fruits of three cultivars from the date palm orchards in al-Ahsa Oasis (Khalas, Shishi and Ruzeize), in Al-Qaseem (Sukkary, Khudry and Segae), in Madinah (Safawi, Anbara, Ajweh). In Riyadh (Khalas, Sagei and Nabtet Seif). The highest losses during harvest time in Al-Ahsa were in Khals, then comes Shishi then Ruzeize. In Qaseem, the least affected variety was Sukkari, then Khudri then Segae. In Medina, Anbara was the most affected variety then comes Safawi then Ajweh. In Riyadh, the most affect variety was Nabtet Seif then comes Khalas then Segae. The average level of loss during the marketing phase was about 5-10 % in most varieties and locations except Ajweh in Riadh (<5%), and Shagra in Qassem (16-20%). The major causes of waste were the dates' small size, and cuts and browses.*

Photography analysis showed that dates are dramatically affected by various pest infestation and non-pathological disorders. The average of general dates disorders or dates damages was 12.6%, which represents the percentage of dates loss of most commonly ones in the major date production regions in Saudi Arabia. In addition, eleven dates variety commercially available were collected at Alahsa dates retail market which produced by the major production regions; Alahsa, Riyadh, Qaseem and Madina. The data showed that the average of general dates disorders or dates damage were the highest for Shishi and Shbibi in AlAhsa (33%), while the lowest was for Ajweh in Medina (2.7% only).

Keywords— Post-Harvest Loss, Waste, Date Palms, Kingdom of Saudi Arabia, harvest time.

I. INTRODUCTION

Saudi Arabia is one of the leading palm dates production and consumption countries, and to a lesser extent, in export, as they ranked, in 2014, third in the world in terms of production (13.9%).

The planted area with date palm trees in the Kingdom in 2014 was about 107 thousand hectares, while the number of palm trees in the same year reached nearly 28 million palm trees. Palm trees are grown in different regions of the Kingdom, which is characterized by the diversity of climate. The most important palm growing areas are the Riyadh region, Qasim, Alahsa and Medina. General. Authority of Statistics, (2015).

New date palm plantations are established in the Kingdom of Saudi Arabia (KSA) which will cause an increase in dates' production which necessitates the adoption of more efficient post-harvest handling, marketing and processing. Dates in the gulf area are considered a backbone for food security and water security in these countries, so it is very important to decrease the level of waste and loss in this sector.

The major problem of the production of dates in the KSA is related to dates processing, where about 7.4% of the production only is processed, though, mainly packing activities, using unspecialized equipment in the field of date sector, but they are also used for other fruits, and therefore the quality is not at the required level.

(Gustavsson et al., 2011) defined post-harvest loss as the decrease of edible food throughout the supply chain that leads to the decrease of edible food for human consumption, while waste refers to the loss at the end of the food chain, i.e. retail and final consumption.

Kitinoja (2016) summarized causes of food loss and waste in the following: a) absence or weaknesses of quality standards, b) Surplus in supply of food c) Lack of appropriate storage facilities, d) deficiency in packing material. Another study was conducted on Harvesting and Post Harvesting Handling of dates to explore the causes of losses, (Kader and Hussein, 2009), where they showed that the main causes of high postharvest losses were fermentation, insect infestation, birds, and mechanical damage.

Food quality is affected by climate conditions such as temperature and light intensity. Moreover, soil type, the rootstock used for fruit trees, mulching, irrigation, fertilization, and other cultural practices affects directly the level of losses in the crops. (Kader, 2012). Post-harvest loss and waste of dates are caused, among other factors, by insects, mites, birds, rats, mollusks and bats or flying foxes. There are other factors that increase dates losses such as physical damages during harvesting, handlings, incidence of physical and physiological disorders and pathogens also contribute to the losses. The date palm farms in The Gulf Cooperation Countries (GCC), mainly in KSA, are characterized by high post-harvest losses due to fermentation, insect infestation, birds and mechanical damage. So as to reduce post-harvest losses it is suggested to improve food security and returns to investment in agricultural research, which will lead to lower food prices, and higher food availability. Rosegrant et. al. (2016). Moreover, loss in food products is considered as loss in resources that produce them, noticing that in these resources such as suitable land and water are limited. Beretta et. al. (2013).

A study conducted by AlQurash (2012) found that pre-harvest fruit drop is a serious problem of some date palm cultivars growing in hot arid regions in Saudi Arabia. Another study was conducted on Harvesting and Post Harvesting Handling of Dates (Kader and Hussein, 2009), they found that there is a need to decrease the postharvest losses caused by fungi, insects, birds, cuts and browses.

In Saudi Arabia, field storage of dates and sun drying, as it is the case in many date-producing countries, subject date to infestation by stored-product insects. Insects cause quantitative and qualitative losses of dates through changing chemical composition, and subsequently, the nutritive value of dates (Scott, 1991).

Insect infestations of dates are most likely started from the field based on certain organic volatile compounds (OVC) from mature stage of dates which paly a fundamental role in insect attraction. The major insect pests attack dates either on the palm tree or during sun drying of dates in field, standing dates awaiting transportation, in storehouses, factories and packing houses. Accordingly, to prevent such infestation in the field and during transit is an important angle in Integrated Pest Management (IPM) of stored dates. There are many preventive and agro-technical methods highly recommended in such respect: dates early harvesting, collect the ripe fruits firsthand and to avoid leaving it on the trees for long periods to prevent insect infestation, use of plastic netting, papers or cloths to cover fruit bunches on trees and harvested dates. Moreover, rapid transportation, clean disinfested containers and inspection of dates while on the tree. In the storehouses, precaution should have be taken: disinfestation of the storehouse using recommended pesticide, cracks sealing, repairing of doors and windows to be insect-proof. Avoidance of mixing fallen dates on the ground with clean ones. In addition, there are certain techniques to protect stored dates, fumigation of dates in storehouses by aluminum phosphide or ethyl formate, modified atmosphere, microwave technology, ozonation and biological control (Abo-El-Saad et al., 2011; Abo-El-Saad et al., 2012; Abo-El-Saad and ElShafie 2013).

This Project aims at evaluating the magnitude and causes of date palm postharvest waste and loss in the main producing areas in the KSA. Moreover, it evaluates the losses in water resource, and fertilizers used to produce these losses.

II. METHODOLOGY

The research was conducted through interviews using questionnaires for all date palm marketing agents, after pre-testing them. Moreover, samples of date fruits were checked for Pest Infestation (e.g. insects, fungi, mites) and Non-Pathological disorders (mechanical, birds and physiological). In addition to evaluation of the percent of the existence of Shees (Un-pollinated fruits) and Besr (immature fruits during harvest time, in the main verities of dates in the kingdom.

The study covered four regions in Saudi Arabia, Al-Ahsa, Al-Qasim, Almadeah, and Al-Riyadh, since they produce more than 80% of Saudi dates.

III. RESULTS AND DISCUSSIONS

3.1 Loss and Waste at Harvest time

3.1.1 AlAhsa Region

Ruzaze variety gave the highest percentage of good fruits (92.36%) with the lowest shees & besr percentage (2.20%). Shishi palm gave 0.6% of fruit infested with dust mite followed by Ruzaze at rate 0.37%, whereas Khalas showed the highest value in this respect (1.26%). In addition, the data revealed that Ruzaze gave the lowest value of dropping (0.04%), while Khalas gave the highest (4.48%). This finding could be due to covering bunches of Ruzaze in plastic sacks. The low percentage of

good fruits of Khalas variety, and at the same time, increase of shees & besr percentage, may be caused by some environmental condition during ripping period or deficiency of some nutrients such as potassium Table 1.

TABLE 1
LOSS AND WASTE OF DATE FRUITS AT HARVEST TIME FOR SOME VARIETIES IN ALAHSA REGION %

Variety	Unaffected	Shees & Besr	Birds	Droppings	Insects	Dust Mites	Total
Khalas	61.19	26.18	3.94	4.48	2.95	1.26	100
Shishi	76.1	17.5	1.2	2.3	2.8	0.1	100
Ruzaze	92.36	2.2	3.4	0.04	1.63	0.37	100

Source: Field Survey

3.1.2 Al-Qasim Region

The quality of the selected cultivars in AlQasim was better than in AlAhsa. The majority (more than 98%) of the produce of the three selected varieties were found healthy. Sukkary gave the highest percentage of healthy fruits compared with Khudry and Segae (99.23%, 98.57% and 97.92% respectively). Segae produced highest value of sheees & bisr compared with Khudry and Sukkary.

In Khudary variety, Shees &Besr is considered as the higher percentage in yield loss (0.75%) then comes fruit droppings (0.3%) then insects (0.28%). In the Segae variety. Shees contributed the highest level of loss (1.19%), while birds and fruit droppings constituted about 0.43% and 0.35% of the loss respectively. Table 2

TABLE 2
LOSS AND WASTE OF DATE FRUITS AT HARVEST TIME FOR SOME VARIETIES IN AL-QASIM REGION %

Variety	Unaffected	Shees&Besr	Birds	Droppings	Insects	Dust Mites	Total
Sukkary	99.23	0.45	0.07	0.01	0.15	0.09	100
Khudari	98.58	0.75	0.08	0.3	0.28	0.01	100
Segie	97.93	1.19	0.43	0.35	0.1	0.0	100

Source: Field Survey

3.1.3 Al-Madena Region

The healthy dates' fruits in Madena constituted about 95.14% of the samples of Ajweh, while they constituted about 89.53% and 82.54% in Safawi and Anbara varieties respectively. The level of loss for Anbara variety was due to sheees &besr (12.22%) then comes birds and Dust Mites (2.73% and 2.05% respectively). On the other hand, that the highest two sources of loss in Ajweh variety were shees &besr and birds (2.88% and 1.83% respectively). Table 3

TABLE 3
LOSS AND WASTE OF DATE FRUITS AT HARVEST TIME FOR SOME VARIETIES IN AL-MADENA REGION %

Variety	Unaffected	Shees & Besr	Birds	Droppings	Insects	Dust Mites	Total
Ajweh	95.14	2.88	1.82	0.15	0.01	0	100
Safawi	89.53	4.67	2.91	1.92	0.21	0.76	100
Anbara	82.54	12.22	2.73	0.43	0.03	2.05	100

Source: Field Survey

3.1.4 Riyadh Region

The healthy dates' fruits in Riyadh constituted about 90.65% of the samples of Segie, while they constituted about 76.5% and 69.49% in Khalas and Nabtet Saif varieties respectively. The level of loss for Khalas variety was due to Shees &Besr (18.56%) then comes birds and fruits droppings (3.91% and 0.9% respectively). In the Segae variety in Riyad, Shees contributed the highest level of loss (6.24%), while birds constituted about 2.98% of the loss, the other factors were not significant. On the other hand, the highest two sources of loss in Nabtet Saif variety were Shees&Bisr and birds (18.74% and 11.77% respectively).Table 4

TABLE 4
LOSS AND WASTE OF DATE FRUITS AT HARVEST TIME FOR SOME VARIETIES IN RIYADH REGION %

Variety	Unaffected	Shees & Besr	Birds	Droppings	Insects	Dust Mites	Total
Khalas	76.5	18.56	3.91	0.9	0.06	0.07	100
Segie	90.65	6.24	2.98	0	0.06	0.07	100
Nabtet Seif	69.49	18.74	11.77	0	0	0	100

The Expected Causes of Damage during Harvesting could be caused by the following factors:

A. Farm husbandry, environmental and physiological factors:

- In vitro fertilization programs should be considered in all aspects in terms of the type of pollination and its efficiency after storing it through the tests of the efficiency of the pollen in the form of the Stocarmine, or through its suitability to pollinate certain varieties. Sometimes there is a state of incompatibility or less fruit formulation percentages causing "Shees". This could be caused by the fact that pollination period is not suitable for receiving pollen or because of the inefficiency of the pollination process or lack of interest in the re-pollination procedure for this period in windy days, so the pollen may not reach the female flowers or washed due to rain because this period is a period of atmospheric fluctuations.
- The high rate of damage in date palms is could be due to the fact that it is a perishable crop after harvest and has limited shelf life or storage. To reduce the loss of date palms after harvest, while maintaining quality as long as possible, first the farmer must be fully aware of the factors of deterioration after the harvest and to know ways and means and techniques to control it.

B. Internal deterioration factors

a. Physiological damage:

- One of the factors of internal degradation that arises from exposure to inappropriate factors before or after harvest, such as food imbalance prior to harvest due to lack of calcium and potassium. Applying calcium and potassium before harvest reduces the chance of the fruits being exposed to such damage and increases their storage capacity.
- The fruits are exposed to many physiological damage due to poor post-harvest storage conditions such as cold damage and high heat damage. In addition to many other physiological damage caused by the imbalance of gases in the atmosphere surrounding the fruits.
- In order to avoid such physiological damage, attention must be paid to agricultural operations prior to harvest, through harvesting and handling, and to optimal storage conditions.

C. External Degradation Factors:

Some of the factors that affect fruits after harvest include temperature, relative humidity, and light, etc. in addition to exposure to mechanical damage and injuries, which will be addressed to their importance as follows:

D. Mechanical Damage:

The fruits are exposed during harvesting, handling, packing and transport for scraping, scratching and falling from different heights. Such mechanical damage leads to the aging of the fruit as quality deteriorates. It is also accompanied by a high rate of respiration and a high rate of loss of their internal moisture. Surface mechanical damage also allows for the growth of many fungi and bacteria, which increases the percentage of rotting fruits during marketing or storage and thus increase the percentage of damage in quantity and quality.

E. Diseases:

Disease is one of the most important factors of the deterioration of the fruits after harvest, and arises from the activity of fungi and bacteria, especially when the high proportion of mechanical defection and non-cleansing or rapid cooling and lack of care of refrigerated storage. There are also some diseases that can result from attacking of the fruits by some microorganisms having mechanical injuries on their outer surfaces.

3.2 Loss and Waste during Marketing

Table 5 summarizes the level of waste information provided by the farmers in the four locations for ten varieties at farm level, which include the loss after harvest. About two thirds of the sample in Qasim reported a waste level of 5-10 %, while in Riyadh more than half of them reported a waste level of more than 20%. Berhi variety followed almost the same pattern as Sukkari in Qasseem and Riyadh. On the other hand, most of the farmers in Qasim and Riyadh who produces Khalas variety reported a waste level of 5-10% while the majority of the farmers (79%) in AlAhsa reported a waste level of about less than 5% of that variety. All farmers who produce Ajweh variety reported that the level of waste level was 5-10%, while Riyadh farmers who produce Ajweh variety reported that the level of waste was less than 5%.

About 75% and 67%, respectively, of Rothana farmers in Qasim and Madena reported that the level of waste is 5-10%. Segie Variety followed the same pattern as Rothana. While all Nabtet saif farmers in Riyad reported a waste level of 5-10%. On the other hand the farmers who produce Shagra variety in Riyadh reported a waste level of less than 5%

TABLE 5
LEVEL OF LOSS OF SELECTED VARIETIES IN SELECTED LOCATIONS (%)

Variety	Location	Percentage Waste					Total
		<5	5-10	11-15	16-20	>20	
Sukkari	Qasim	3	69		9	19	100
	Riyadh	14	15	14		57	100
Berhi	Qasim	6	65			29	100
	Riyadh		12	18	6	64	100
Khalas	Qasim	4	88		4	4	100
	AlAhsa	79	19	2			100
	Riyadh	24	76				100
Aqweh	Qasim		100				100
	Medinah		100				100
	Riyadh	100					100
Rothana	Qasim	17	75		8		100
	Madenah	33	67				100
Segie	Qasim		78		11	11	100
	Riyadh	30	70				100
Nabtet Saif	Qasim		67		33		100
	Riyadh		100				100
Shagra	Qasim				100		100
	AlAhsa	60	40				100
	Riyadh	100					100
Ruzaze	AlAhsa	73	9		9	9	100
	Riyadh	60	40				100
Khudri	Qasim		100				100
	Riyadh	50	50				100

Source: Field Survey

Table 6 shows the source of loss in eight varieties in the four location. In Sukkari variety, small size constituted one third of the sources for loss while in Riyadh, cuts and browses constituted two thirds of the cause of loss. The small size of Berhi in Qasim constituted about one half of loss causes while cuts and prowess constituted about half the loss causes in Riyadh. The insects were the major cause of loss in Alahsa for Khalas variety (87%). Moreover, insects were the major causes of loss in Khudry in Qasim (60%).

Table 5.10, also shows that the major cause of loss for all the selected varieties was cuts and browses (about 48%), then comes size then insects (24% and 18% respectively. In Qasim, size is considered the main factor of loss for all the studied varieties in the region (39%), while about 21% of loose causes in this region is caused by cuts and browses, and the same percentage for insects.

The main factor of loss in Riyadh was cuts and browses (57%) then comes size (31%). In AlAhsa, the main cases of loss were insects (76%), while in Medina, only cuts and browses causes loss (100%).

On the other hand, the main cause of loss for Sukkai in all the regions was cuts and browses (63%), then comes size (21%) then insects (12%). The same pattern was found for Berhi, i.e. cuts and browses cased loss by 54%, while size and insects cased loss by 30% and 12% respectively. An insect were considered the main causes for loss in Khalas Variety (43%) then comes size then cuts and browses (23% and 21% respectively).

As for the mode of transportation, most of the farmers use pickups called Dyanawith a carrying capacity of 5 tons, and since the distance between the farms and the market is relatively short, these farmers said that there is no loss during transportation, except for Segei (about 22.5%).

The loss during Storing the products were recorded for three varieties only, they are: 5% for Sukkari, 7.5% for Khalas, and 2.4% for Khudri.

TABLE 6
SOURCES OF LOSS IN THE SELECTED VARIETIES IN THE STUDY AREA (%)

Variety	Location	Sources of Loss for Selected Varieties						Total
		Size	Cuts And Browses	Insects	Color	Buyer Refusal	Others	
Sukkari	Qasim	31	28	28	6	3	3	100
	Reyadh	31	62	8				100
	Madena		100					100
Berhi	Qasim	52	12	24		6	6	100
	Reyadh	37	50	13				100
	Madena		100					100
Khalas	Qasim	40	12	28	12		8	100
	Alahsa			87			13	100
	Reyadh	33	52	15				100
Ajweh	Qasim		50	25			25	100
	Reyadh	33	67					100
Rothana	Qasim	28	18	27	9		18	100
	Reyadh	30	50	20				100
Segie	Qasim	45		22	11	11	11	100
	Reyadh	53	42				5	100
	Madina		75				25	100
Ruzaze	Alahsa		18	64			18	100
	Reyadh		80	20				100
Nabtet Saif	Qasim	67	33					100
	Reyadh	30	50				20	100
	Madena		100					100
Average		**24**	**48**	**18**	**2**	**1**	**7**	**100**

Source: Field Survey

3.3 Waste and Loss at Processing and Retail Levels

This section discusses the level of waste and loss (caused by) physiological and non-pathological disorders) and loss (caused by pest infestation in date ready for sale to the consumers.

Twenty dates varieties produced in different regions in Saudi Arabia have been collected from Alahsa national date factory during the seasons 2014- 2015 (during Sep-Dec). Fig. (1) Shows the pest infestation, physiological and non-pathological disorders of dates, where insect disorders obviously shown (Fig. 1a), pathological disorders of dates caused by fungi (Fig. 1b), mite disorders (Fig. 1c), physiological disorders (Fig. 1d), bird disorders (Fig. 1 e), mechanical disorders (Fig. 1 f). These disorders of dates are represented main disorders that could be reflect the actual losses of dates caused by pest infestation results in dates damage that cannot be repaired, therefore dates loss includes; loss of weight, loss of nutrients, reduced grade, lower market value and/or contamination. The highest rates of general distortions where the highest in AlAhsa region.

Table 6 summarizes the average disorders in the selected varieties and regions. The highest level of waste and loss was in Shisi in AlAhsa (33.3%) then comes Minifi (21.78%) variety in Riyadh region. The lowest level of Loss was in Ajweh Variety in Madina (2.67%), the grand average of the selected varieties was 12.19%.

This data is consistent with those indicated by Kader and Hussein, (2009) who reported the importance of dates as a healthy foods and numerous pests capable to attack it (Abo-El-Saad and El-Shafie 2013).

It was found that the most causes of postharvest losses in quality and quantity are insect infestation and damage caused by insect feeding on the dates. The main insect infestation occurs by stored-products insects (such as Oryzaephilus surinamensis, Oryzaephilus mercator, Tribolium confusum, Plodia interpunctella, Cryptolestes ferrugineus, and Cadra spp.). To decrease or get rid of insect in by using forced air. On the other hand, yeast, molds and bacteria cause microbial waste.

Finally, we could conclude that pest infestation and non-pathological damages of dates were relatively high, reaching 12.19% in dates of Saudi Arabia at both level, either dates which the government buying from farmers through national date factories or dates commercially available at dates retail marketing respectively. Therefore, management of pest attack dates and non-pathological damages, (e.g. mechanical, physiological) under pre- and post-harvesting conditions is the key element to reduce such dates disorder.

INSECT DISORDERS OF DATES

PATHOLOGICAL DISORDERS OF DATES CAUSED BY FUNGI


MITE DISORDERS OF DATES


PHYSIOLOGICAL DISORDERS OF DATES


BIRD DISORDERS OF DATES


MECHANICAL DISORDERS OF DATES

FIGURE 1: PEST INFESTATION, PHYSIOLOGICAL AND NON-PATHOLOGICAL DISORDERS OF DATES COLLECTED RANDOMLY FROM ALAHSA DATES FCTORY

TABLE 6
MEAN OF GENERAL DISORDERS OF VARIOUS DATE VARIETIES RESULTED FROM PEST INFESTATION AND NON-PATHOLOGICAL DISORDERS IN SELECTED VARIETIES IN DIFFERENT REGIONS IN SAUDI ARABIA

No.	Variety of dates	Production region	Mean of general disorders (%)
1.	Khalas	Alahsa	19.30
2.	Ruzaze	Alahsa	21.00
3.	Shishi	Alahsa	33.30
5.	Khudry	Riyadh	9.18
9.	Salaj	Riyadh	9.32
10.	Berhi	Riyadh	12.28
11.	Minifi	Riyadh	21.78
12.	Sukkary	Qaseem	4.07
13.	Shagra	Qaseem	19.86
14.	Berhi	Qaseem	14.58
15.	Berhi	Madina	13.70
20	Anbara	Madina	4.67
21	Sukkary	Madina	4.00
22	Khudri	Madina	4.00
23	Safawi	Madina	5.00
25	Ajweh	Madina	2.67
	Average		12.19

Source: Field Survey

IV. ECONOMIC AND WATER AND FERTILIZERS LOSS DUE TO DATES LOSS

Total production of dates in 2014 was about 767 thousand tons. The average wholesale price of dates in the same year was about 11.67 SR/Kg.

The total loss during marketing process of dates was estimated in this study at 7.8%. This means that about 60 thousand tons of dates were lost, at a total value of SAR[1] 698 thousand annually.

The total number of date palm trees in 2015 was about 28 million trees, out of which about 22.7 million bearing trees. The estimated average number of trees per dunum is about 14.3 trees. The average water consumption of one dunum planted with date palm trees is estimated at 23 thousand cubic meter, then the average loss of water due to dates loss is about 190 thousand cubic meter of irrigation water.

Three main fertilizers are used in date palm production, they are: DAP (compound fertilizer), Urea, and potassium Sulfate, the cost of these fertilizes was estimated at 905 SAR/dunum. The total Area for date Palm was 767 thousand dunums in 2014 (Agricultural Census, 2015), thus the total annual cost of fertilizes in this sector is about SAR 958350, and the values of loss will be, given the above loss weight, 75 thousand SAR.

V. CONCLUSIONS

Saudi Arabia is one of the leading countries in the world in producing dates. on the other hand, its exports do not match the large production of this crop.

The level of loss at harvesting time differs from region to region and from variety to another. For example, the loss in khalas variety during harvesting in AlAhsa was about 38% compared to Ruzaze which had loss at only 7.5%. On the other hand, the loos in Sukkari in Qassim reached about 0.8% and for Segei 2%.

The level of waste during the marketing phase differs from region to region and from from to variety to other variety, for example, the percentage of loss in most of the selected varieties in Qasim was5-10%. On the other hand, the majority level of waste of Khalas variety in Qasim was about 5-10% while in AlAhsa was less than 5%. The source of loss in Sukkari variety caused by small size constituted one third of the sources for loss while in Riyadh, cuts and browses constituted two thirds of the cause of loss. The small size of Berhi in Qasim constituted about one half of loss causes while cuts and prowess constituted about half the loss causes in Riyadh. The insects were the major cause of loss in Alahsa for Khalas variety (87%).

[1] 1 US$=3.75 SAR (Saudi Arabia Rial)

Moreover, insects were the major causes of loss in Khudry in Qasim (60%). The study also found that pest infestation and non-pathological damages of dates were relatively high, reaching 12.19% in dates of Saudi Arabia at both level, either dates which the government buying from farmers through national date factories or dates commercially available at dates retail marketing respectively.

The average water consumption of one dunum planted with date palm trees is estimated at 23 thousand cubic meter, then the estimated average loss of water due to dates loss is about 190 thousand cubic meter of irrigation water.

The main problems that faced the study team was the absence of landlords which made it difficult to get information from the workers who do not know the detailed needed information.

VI. RECOMMENDATIONS

The study recommends the following:

- Proposed program to reduce the loss at harvest is as follows:
    - Increase the Awareness of date palm growers in areas that recorded high rates of loss such as Al-Ahsa area with the best agricultural operations to maintain them, as well as improving quality, which helps to increase the net yield and thus increase the interest of date producers in that region.
    - Decrease the level of loss during harvesting through using good husbandry practices, mainly irrigation and fertilization. In addition, we recommend for the farmers to use nets to protect the fruits from birds, insects, and mites.
    - Conduct awareness field days. The Date Palm Center of Excellence at King Faisal University is currently establishing field days in collaboration with the Agricultural Extension Department, Agricultural Directorate in Al-Ahsa in the different production areas for awareness raising and training farmers to improve the quality of dates and reduce losses.
- Add proper quantities of Potassium and calcium fertilizers at the recommended periods, this will affect fruits ripening.
- Implement best management for pests that attack dates and non-pathological damages, (e.g. mechanical, physiological) under pre- and post-harvesting conditions is the key element to reduce such dates disorder.
- Conduct proper fumigation for the stored dates to reduce loss during storing the dates' fruits.
- Dates sector need quality certificates, including quality and good farming practices known as (Global GAP), as well as organic farming, which is part of good agricultural practices.

VII. ACKNOWLEDGMENT

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Continuously flow microwave pre-treatment for enhanced anaerobic biodegradability of dairy industry sludge

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***Abstract*— *Our research has focused on the investigation of the applicability of continuously flow microwave pre-treatment process for anaerobic digestion of dairy industry sludge. In the continuously flow operation effects of microwave specific process parameters, i.e. specific irradiated energy and microwave power level, were examined on the biogas yield and anaerobic digestion rate. Furthermore, the efficiency of process was characterized based on energetic analysis, as well. Our results show, that depend on the irradiated energy level the microwave power has effect on biogas yield, and determine the biodegradation rate, as well. Higher energy irradiation or higher power has been manifested in enhanced anaerobic digestion, but over a certain value of them led to worsened methane content. Considering the results obtained from energetic analysis can be concluded, that microwave pre-treatment followed by anaerobic digestion is efficient if irradiated energy was kept lower level (100 kJ L^{-1}, in present experiments) with microwave power levels of 536 W, or 700W, respectively. Too high energy intensity at high power level, or too low microwave power, independently from the extent of irradiated energy, led to higher energy demand of pre-treatment, than can be recovered as energy content of surplus biogas.*

Keywords*— *anaerobic digestion, biogas, energy efficiency, microwave, sludge.

I. INTRODUCTION

Wastewater and sludge pre-treatments can be divided three major groups: chemical processes, thermal processes and biological processes. Chemical treatments are efficient, but many times cause corrosion problem in wastewater line, in equipment and tanks, or generate undesirable side-products. Biological processes can be considered more environmentally friendly than chemical treatments, but need longer time and considered more sensitive for the change and fluctuation of process parameters (temperature, pH, ionic strength, presence of inhibiting or toxic components, homogeneity of the material matrix etc.). Heat treatments has numerous advantages over the other processes, such as no formation of undesirable by-product, more flexibility to unsteady capacity, good controllability, high number of pre-designed and modular industrial scale equipment etc. Compared to the conventional heating microwave irradiation has higher heating rate, heating equipment operated by microwaves requires less space, and using well designed system and intermittent irradiation mode the energetic efficiency is higher than conventional method (Cuccurullo et al., 2013).

In high frequency oscillating electromagnetic field, because of the fast change of polarity, the dipolar components of irradiated medium vibrated and oscillated, and, furthermore movement of ionic compounds or charged particles has also been occurred. These effects led to intramolecular friction resulted in internal heat generation. The electromagnetic energy interact directly with the components of materials, the medium absorb the energy and convert it into heat (Mawioo et al., 2016). Considering the specific heat generation mechanisms of microwave irradiation, in real and complex medium, such as the wastewater, composition, dielectric properties of compounds, intermolecular interaction, chemical structure of molecules, physicochemical state, temperature, viscosity and density of continuous phase and their possible alteration during irradiation, furthermore the frequency of electromagnetic field has also effect on the thermal efficiency of heating (Holtze et al., 2006). Another interesting phenomenon of microwave irradiation is the selective heating. If components of a system have different dielectric behavior (dielectric constant, and/or dielectric loss) during irradiation the heating rate of solely components is different. Therefor the temperature difference, occurred by different energy absorption, can led to thermal stress inside of the material structure, or inside of microbial cell, or tissues.

In wastewater and sludge organic matters are partially present in particular form. In many cases the conventionally used wastewater purification processes aim the coagulation and flocculation of soluble organic and inorganic pollutants, transform them insoluble, particulate form. During phase separation processes, these components can be concentrated into sludge. But if the further utilization of wastewater or sludge is planned, for example in anaerobic digestion process, increasing of organic

matter solubility is expediential for enhanced organic matter removal efficiency, biogas production rate and higher biogas yield.

Among sludge management options anaerobic digestion (AD) has been more and more popular at wastewater treatment plant. The main advantage of AD is that sludge stabilization and energy generation can be carried out simultaneously. The output of AD cannot be considered obviously 'final waste', because digestate has a good potential for agricultural utilization, as fertilizer. One of the main problem for application of AD in-line at wastewater treatment plant (WWTP) is the long retention time. On the one hand the slow degradation increase the capital and running costs, and on the other hand present bottleneck for the overall capacity of WWTPs. Therefore, beside the enhanced dewaterability and microbial stabilization of sludge, pre-treatments serve as intensification process for AD. Results from the comparison of conventional heating and microwave irradiation for wastewater and sludge pre-treatment are contradictionally. Detach of non-thermal effects of microwave from thermal effects is difficult, because mainly of high temperature ramp and hot-spot heating effects occurred during microwave irradiation (Sólyom et al., 2011). It can be noticed, that in practice the same condition for conventional- and microwave heating in real material matrix cannot be ensured.

Beyond above mentioned difficulties microwave irradiation has verified positive effect on organic matters of wastewater and sludge, which can be utilizable as pre-treatment followed by AD. Microwave has strong effect on microbial destruction, microwave process need significantly shorter time demand than needed for conventional heat treatments. Depending on the heating rate and final temperature during the processes, with the application of microwave pre-treatments higher disintegration degree can be achieved. Therefore the higher disintegration degree and higher organic matter solubility led to higher biogas yield in AD process. Beside absolute value of biogas production, the biogas production rate presents key issue to evaluate the efficiency of a pre-treatment method. Depending on the material characteristics and heating rate and final temperature, microwave pre-treatments are suitable to increase the degradation rate, therefore accelerate the biogas production (Yang et al., 2013).

Efficiency of microwave pre-treatments depends on the type and condition of anaerobic digestion. Thermophilic digestion suitable to achieve higher biogas product, the effect of pre-treatments are slightly than that of obtained for mesophilic temperature ranged AD tests. It was found that there was no significant difference between the effects of conventional and microwave heating method on biogas yield, but temperature ramp considered as the main influential process parameter in high total solid contented sludge cake processing followed by thermophile anaerobic digestion. On the other hand, beside the temperature ramp has significant effect on biodegradation rate, as well (Koupaie and Eskicioglu, 2016). But in Europe mesophilic AD process can be considered the commonly usable and economic method, therefore the pre-treatment efficiency need to be investigated at this temperature range.

Summarized the experiences of laboratory scale batch microwave wastewater and sludge pre-treatment can be concluded that preliminary results can be considered promising. But extend the investigation for implementation of continuously flow microwave pre-treatments is need to evaluate the applicability of method, find the main influential microwave related process parameters, model and optimization of the process to make suitable the scale up (Boldor et al., 2008). Another key issue for investigation of applicability of sludge and wastewater treatment operated by microwave heating is the temperature range. Considering the disintegration degree as control parameters for pre-treatment solely, pre-treatment over 100 °C cause significantly higher increments in organic matters solubilisations. In multicomponent medium, such as food industry wastewater and sludge, application of elevated pre-treatment temperature led to Maillard reactions, in which refractory compounds are formed from amino acids and reducing sugars, and other polymerization reactions are occurred in the presence of low molecular weighted, easily degradable intermediates (Shahriari et al., 2010). Therefore, change of biogas production due to microwave pre-treatment cannot be intrinsically estimated based on solubilisation ratio alone (Koupaie and Eckicioglu, 2015). Because of evaporation in open vessel system, and polymerization reactions, over a certain value of final temperature and/or temperature ramp during microwaving process the biogas potential of some part of organic matters decrease.

II. MATERIAL AND METHOD

Sludge processed in our experiments has been originated from dairy industry process. Thickened dairy sludge has a TS content of 3.8 ± 0.2 w%, and chemical oxygen demand of 48590 ± 352 mgL^{-1}, respectively. The fresh collected sludge was stored refrigerated at 6 °C before using in closed PP container.

Anaerobic biodegradability of sludge samples was assessed under mesophilic conditions at 37 ± 0.5°C for 30 days. Anaerobic digestion tests were carried out triplicated in 250 mL sealed bottles in a continuously stirred batch laboratory system. For seeding an industrial anaerobic digester sludge of the local wastewater treatment plant was used in 10 w/w% concentrations on dry matter basis. Acclimatization of inoculum was carried out the same temperature as applied for AD tests using pre-treated sludge as substrate.

Blank test was run to determine the own endogenous biogas production of seed sludge, and the blank value was subtracted from the results obtained from real sludge digestion. The initial pH of sludge mixed with inoculum was adjusted to 7.4. To ensure the anaerobic condition for AD tests bottles were flushed by N_2 gas using the double septum of reactor bottles.

Biogas production was measured by the pressure change in the headspace of reactor bottles. Pressure change was detected daily by OxiTop® Control (WTW, Germany) manometric measuring heads attached to the anaerobic reactors. Volume of biogas was calculated by the ideal gas law. Specific anaerobic digestion activity ($mLg_{TS}^{-1}day^{-1}$) was calculated from the first 10 days linear phase of the cumulative biogas production curve. Methane content of produced biogas was measured by a portable biogas analyser (airTOX, Fresenius Umwelttechnik, Germany) after the 30 days digestion. Total solid content (TS) was determined by gravimetric analysis.

Microwave pre-treatment was carried out in a custom made continuously flow equipment. Magnetron equipped in microwave reactor operated at a frequency of 2450 MHz, the power was continuously changeable in the range of 200-700W by adjustment of heating voltage. The volumetric flow rate of sludge through the toroidal type microwave cavity resonator was varied by the revolution of peristaltic pump. Coil tube implemented into the microwave cavity resonator has an inner diameter of 16 mm, and, because of minimal energy loss made from polytetrafluoroethylene (PTFE). To reduce the air and steam bubble forming processed sludge enters up flow from the bottom of resonator. The system has operated in open mode. Tuning screws in waveguide were adjusted to minimal power reflection to achieve high energy efficiency and to protect magnetron from overheating.

Specific microwave irradiated energy (E_s, $kJ\ L^{-1}$) was calculated from the volumetric flow rate of sludge (Q, Lh^{-1}) and the power of magnetron (P_m, W) by Eq. (1).

$$E_s = \frac{P_m}{Q}\ (kJ\ L^{-1}) \tag{1}$$

Considering the calculation method of E_s the same specific microwave irradiated energy can be achieved by the different combination of microwave power and volumetric flow rate. Specific net energy production (NE_p, $kJ\ L^{-1}$) of pre-treatment was calculated based on the volume of produced biogas (V_{bg}, L), methane content of biogas (v%), energy content of methane (H=39 $kJ\ L^{-1}$), microwave power (P_m, W), residence time of sludge in cavity (t, s) and the volume of irradiated sludge in resonator (V_{sl}, L) using Eq. (2) .

$$NE_p = \frac{\left(V_{bg}\ \frac{v\%}{100}\ H\right) - \frac{P_m\ t}{1000}}{V_{sl}}\quad (kJ\ L^{-1}) \tag{2}$$

III. RESULTS AND DISCUSSION

Results of mesophilic AD tests show, that biogas yield from dairy sludge can be improved by the continuously flow microwave pre-treatments. Compared to the untreated (control) sample, which has a biogas yield of 128 ± 6.9 mL g_{TS}^{-1} , microwave pre-treatments could enhance the specific volume of biogas over 400 mL g_{TS}^{-1} (Fig 1).

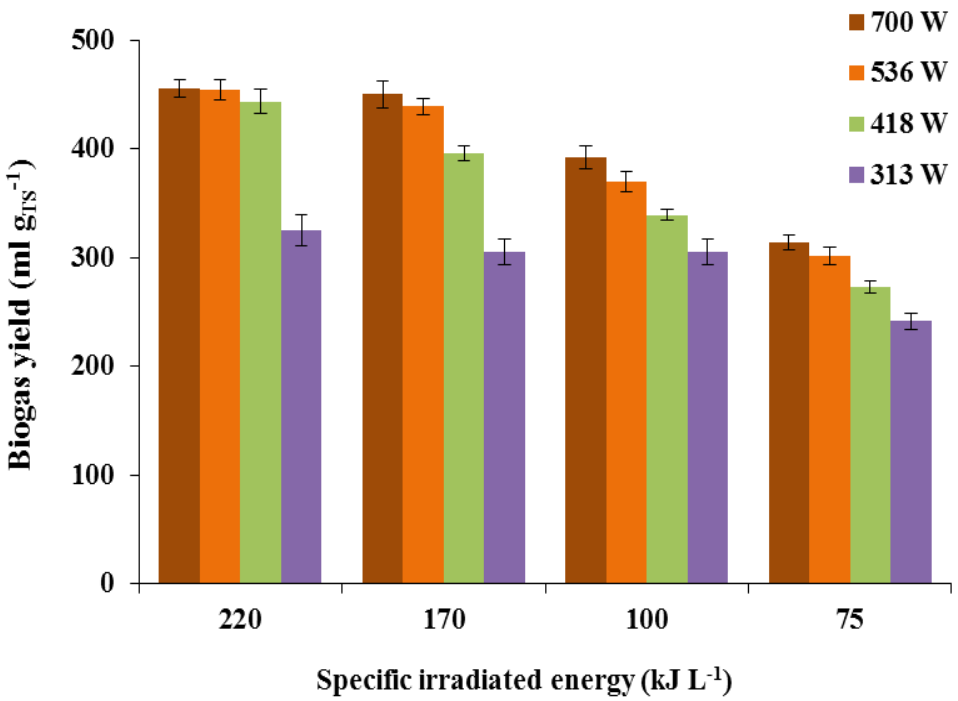

FIG 1— BIOGAS YIELD OF MICROWAVE PRE-TREATED SLUDGE

Our earlier results related to batch pre-treatment (Beszedes et al., 2011) and others studies (Yang et al., 2013) suggested that microwave power level can affect the anaerobic biodegradability of sludge. Investigation of the effects continuously flow microwave pre-treatment process on biogas yield achievable in 30 days digestion verified, that beside the irradiated energy, the microwave power level can be considered as influential process parameter, as well. Applying the highest specific irradiated energy effects of microwave power in the range of 418-700W does not led to significant difference in biogas yield, but by lower energy pre-treatments (170-100 kJ L^{-1}) the higher power resulted in higher biogas production. Maximum biogas yield was achievable by microwaving at power of 536 W and 700 W, and irradiating of sludge with 170 and 220 kJ L^{-1} energy.

From practical purposes, and from the aspects of operating parameters and stability of an industrial scale anaerobic digestion plant, beyond the biogas yield, the rate of anaerobic digestion can provide valuable information to evaluate and appreciate of the efficiency of pre-treatment processes. To quantify the effects of microwave pre-treatments with different energy intensity and microwave power the anaerobic digestion activity was calculated, defined the control parameter as the biogas production rate of linear phase of the cumulative biogas production curve. Specific anaerobic digestion activity is well correlate with the rate of decomposition of organic matters during the fermentation process.

Notwithstanding the high organic matter content, because of the sludge structure, high extracellular polymeric substances (Serrano et al., 2016) and presence of heavily degradable components from disinfection and cleaning process, dairy originated sludge has lower than theoretical biogas production and can be characterized by slow biodegradation rate. In our experiences, the average daily mesophilic anaerobic digestion activity determined for untreated dairy sludge was 8.7 ± 2.1 mLg_{TS}^{-1}. Results of calculation verified, that in addition to biogas yield, the rate of anaerobic digestion can be enhanced by the continuously flow microwave pre-treatment. Similar to the results regard to biogas yield, depend on the specific irradiated energy, digestion activity can be influenced by both the microwave power, and irradiated energy. Using the energy irradiation level of 220 and 75 kJ L^{-1}, varying of microwave power in the range of 418-700W has not significant effect, but microwave power determined significantly the digestion activity if 170 kJ L^{-1} energy was irradiated during pre-treatment (Fig 2). It can be summarized, that increasing of microwave power at the same energy irradiation level can accelerate the anaerobic digestion process, but the actual scale, size and significance of effects was determined by the energy level, as well.

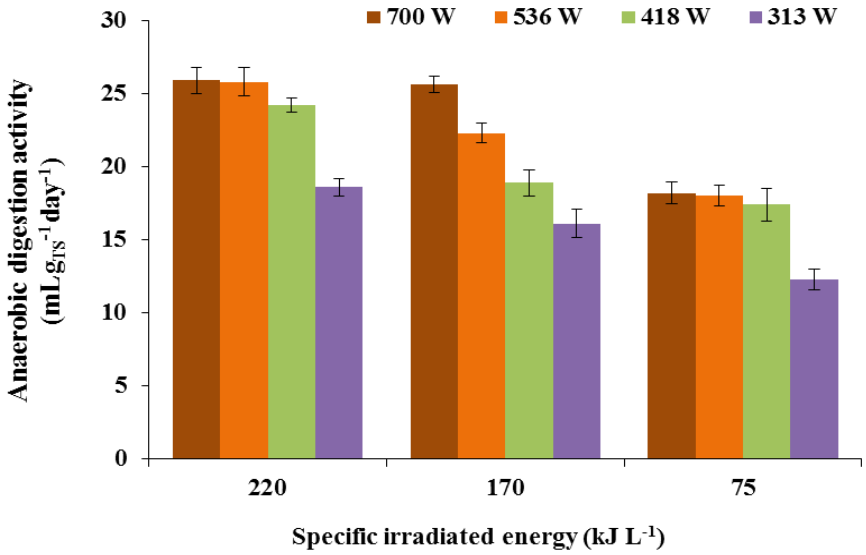

FIG 2— ANAEROBIC DIGESTION ACTIVITY FOR THE FIRST 10 DAYS PERIOD

Although the anaerobic digestion rate has strong effect on the stability of capacity in continuous digesters, because it has influenced by the organic matter removal efficiency, hydraulic retention time and applicable organic matter loading rate; the calorific value of produced biogas is also important parameter for the overall economy of AD technology. For this purpose, the final methane content of produced biogas was also measured at the end of 30 days anaerobic fermentation process.

Raw dairy industry sludge has low methane content (41%) , but as a results of microwave pre-treatment the calorific value of biogas was improved. Beside that microwave irradiation is generally suitable to increase the methane content in produced biogas, it can be noticed, that despite of higher biogas yield and anaerobic digestion activity, pre-treatment with high energy intensity and higher microwave power led to decreasing tendency in the change of methane content. Irradiating energy of 220 and 170 kJ L^{-1} , and increasing of microwave power 700 W from 536 W methane content of biogas decreased (Fig 3). In other energy levels increasing of microwave power led to improvement of methane ratio. Higher biogas yield with lower methane content revealed that microwave treatment was supposed to be suitable to assist in hydrolysis of macromolecules, possibly enhance the efficiency of acidogenesis, but product and/or byproduct of earlier stages of AD process can not be utilizable for microbes of methanogenesis stage (Shahriari et al., 2011).

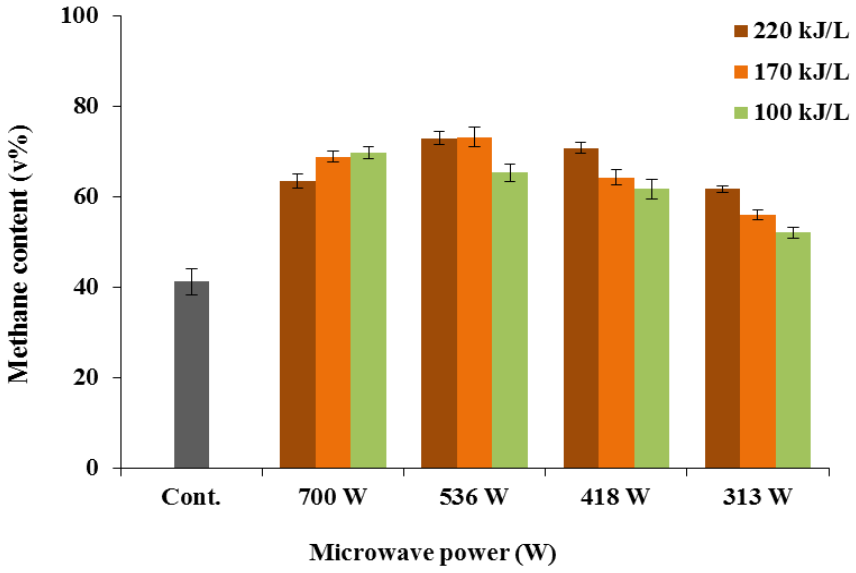

FIG 3— METHANE/BIOGAS RATIO AS FUNCTION OF MICROWAVE POWER AND IRRADIATED ENERGY

Opposite tendencies observed for the change in methane content and biogas yield at higher intensity and higher microwave power necessitates the investigation of energetic efficiency of pre-treatments. One of the simplest methods to quantify the energy efficiency of microwave treatments followed by anaerobic digestion is to calculate the net energy production as the difference between the energy content of the produced surplus biogas and energy demand of microwave process. Results of our calculation indicated that energy content of low power (313 W) microwave pre-treatments, independently from the applied irradiated energy, have not resulted in enough biogas production to compensate the energy demand of microwave process. On the other hand, despite to higher biogas production of sludge processed by high energy intensity and high power microwave irradiation, the energy demand of pre-treatment exceeded the energy content of produced biogas, therefore the process was disadvantageous from energetically aspects (Fig 4).

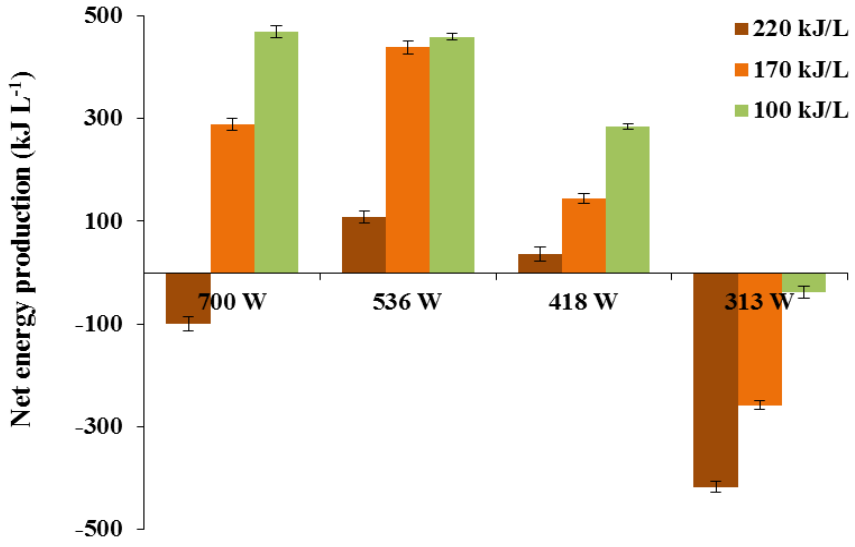

FIG 4— SPECIFIC NET ENERGY PRODUCTION OF PRE-TREATED SLUDGE

Based on the net specific energy production values, from energetically aspects, pre-treatments carried out with 100 kJ L^{-1} energy irradiation at 536 and 700W microwave power, and 170 kJ L^{-1} at 536 W power can be considered the more advantageous for the continuously flow microwave pre-treatment of dairy industry sludge. Further investigation is needed to determine the thermal efficiency of microwave heating to analyze the electrical energy transformation parameters and get more complete information of the overall energy efficiency of microwave sludge pre-treatment process.

IV. CONCLUSION

The main objective of this research effort was to investigate the effect and efficiency of continuously flow microwave irradiation method, as pre-treatment for anaerobic digestion of dairy industry sludge. Our results show, that biogas yield from sludge, and as well as the anaerobic digestion activity of processed biomass, can be improved by microwave pre-treatments. Depending on the extent of energy irradiation into the continuously flow sludge, the microwave power level can have significant effect on the efficiency and rate of anaerobic digestion process. Methane content of biogas was improvable by microwave irradiation, but over a certain value, the high energy intensity and high power microwaving can deteriorate the calorific value of produced biogas.

Results of energy retrieval of microwave pre-treatments during mesophilic anaerobic digestion show, that the energy efficiency of the continuously flow mode process was influenced by the irradiated energy and microwave power, as well. From energetic aspects, the lower energy pre-treatments (100-170 kJ L^{-1}) carried out at higher microwave power level (536-700W) can be considered as favorable. Further investigations are needed to analyze the dielectric behavior of materials during microwave irradiation, and to measure the real power dissipation as a function of flow properties, to get more complete information about the overall energy efficiency and to optimize the continuously flow microwave pre-treatment process.

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Preservative Effects of Different Treatments and Their Flavor Acceptability in Cashew Apple and Pineapple Blend Juice

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***Abstract*—** *The aim of this study is to evaluate the stability of a cashew apple and pineapple blend juice (25:75 v / v). Various treatments were applied, including pasteurization (92 C, 15 min), aqueous extract of ginger (2.5 and 10%) and potassium sorbate (1g/kg). The physicochemical results revealed that the addition of the aqueous extract of ginger caused an increase in the content of ascorbic acid, total sugars, proteins and minerals such as magnesium, potassium, phosphorus and zinc. The microbiological analysis showed lower microbial counts of the treated samples compared to the control. The different treatments could have an antimicrobial effect. The sensory analysis reveals a general acceptability for all the samples formulated. This acceptability value is higher for the sample supplemented with 10% aqueous extract of ginger. With a view to preservation without chemical preservatives while improving nutrient content, the 10% aqueous ginger extract could help extend the shelf life of fruit juice drinks.*

***Keywords*— Drink, pineapple, cashew apple, preservatives, quality.**

I. INTRODUCTION

Ivory Coast is the leading producer of cashew nuts since 2015 with a production of 725 000 tons (CCA, 2016). Cashew apple, a pseudo fruit of the cashew tree, is rich in vitamins C, polyphenols (Michodjehoun-Mestres et al., 2009) and also contains a significant amount of carotenoids (Assunção and Mercadante 2003, Abreu 2012). However, almost all cashew apples are lost at harvesting sites because of their astringency and certain taboos (Soro et al., 2008). To remedy this, a drink formulation containing cashew apple and pineapple juice was produced. Pineapple (Ananas comosus) is a non-astringent, less acidic fruit that is mature and consumed much in the world. Moreover, in the fresh state, it contains several enzymes including bromelain which facilitates the digestion and assimilation of proteins, by fractionating the amino acid chains (Sekhar et al., 2013). Thus, the mixture of the two fruit juices can result in a product enriched with vitamins, minerals and good sensory characteristics when compared to the starting raw materials (Akinwale 2000, Rodrigo et al 2003, Jain and Khurdiya 2004). Like all fruit juices, this drink must retain its organoleptic and microbiological qualities over time. Indeed, one of the difficulties for the large-scale production of fruit juices is their stability. The same is true for unstabilized cashew apple juice, which has a very short shelf life because yeast attacks the juice and fermentation even at refrigeration temperature.

There is a need to explore several methods of stabilization to extend the shelf life of juices. Thus, the use of certain chemical preservatives such as sorbate and benzoate improves the shelf life of beverages (Dougheri et al., 2007, Nwachukwu and Ezeigbo, 2013). However, the use of chemical preservatives in nutrition tends to have detrimental effects on consumer health (Adesokan et al., 2010). Also, the current trend is towards biological preservatives (aliu et al., 2007). Among these biological preservatives, ginger (zingiber officinale) is traditionally used as a spice in preparations (Kolapo et al., 2007) for its antioxidant and antimicrobial activity. According to Smith-Palmer et al. (1998), ginger has a bactericidal effect against E. coli and Streptococcus.

The objective of this study is to assess the preservative effects of different treatments and their flavor acceptability in cashew apple and pineapple blend juice.

II. MATERIALS AND METHODS

1.1. Biological materiel

The plant material used consists of cashew apples (Anacardium occidentale L. Anacardiaceae), pineapple (Ananas comosus) and rhizomes of ginger (zingiber officinale). The cashew apples used, made up of red and yellow apples, came from the center of Cote d'Ivoire. The pineapple used is of smooth Cayenne variety in the mature stage. Pineapple and ginger rhizomes were purchased at the large market in Yamoussoukro, Côte d'Ivoire.

1.1.1. Preparation of the aqueous extract of ginger

The ginger rhizomes were washed four times with drinking water. They were stripped of their peels using a sterile stainless steel knife. The rhizomes were then cut into dice and then dried in the shade. The ginger was then pulverized. The powder obtained was dissolved in 50 ml of distilled water and then washed with 100 ml of distilled water and filtered with a muslin cloth. The obtained solution was evaporated to obtain a dry extract which was dissolved in 100 ml of distilled water to obtain the aqueous extract of ginger. This extract was stored in pre-sterilized glass bottles in a refrigerator at 4 ° C until use.

1.1.2. Extraction of cashew apple juice

The fruits harvested consist of apples and cashews. The apples were carefully separated from the nuts by means of a wire attached at both ends by small pieces of wood to avoid damaging them. The apples obtained were soaked in chlorinated water at 100 ppm of active chlorine for 20 minutes and then rinsed with potable water. The grinding was carried out using a screw press (ZBK220077-88 LW74d (B) A (China). This press has a power of 4.4 kW with a rotation speed of the screw of 1440 rpm.min-1. The juice was then filtered with a mesh screen of 1 mm in diameter and then packed in 5-liter cans and stored at -10 ° C. before the cocktail was formulated.

1.1.3. Extraction of pineapple juice

The pineapples were soaked in 100 ml chlorine bleach for 20 minutes and then rinsed with clean water. After washing, the pineapples were peeled, cut and then crushed using the same pulp press ZBK220077-88LW74d (B) A (China). The juice expressed was filtered with a mesh screen of 1 mm diameter under aseptic conditions and then packed in 5 liter cans and stored in a cold room at -10 ° C. before the various formulations of the cocktail.

1.1.4. Formulation of cashew apple and pineapple beverage

The cashew apple and pineapple juices were mixed in 25:75 (v/v) proportions respectively to have the cashew apple and pineapple drink. To this formulated beverage various stabilizers including, aqueous ginger extract at concentrations of 2.5 and 10%, potassium sorbate at 1 g/kg. Five (5) formulations were obtained with the various stabilizers, namely the control formulation E0; Formulation EG2.5 containing 2.5% aqueous extract of ginger; The formulation EG10 containing 10% ginger; The EP formulation which is the pasteurized beverage sample and the ES formulation containing potassium sorbate (1g / kg). The various samples were placed in PET bottles (polyethylene terephthalate) and stored at 4 ° C.

1.2. Physico-chemical analyses

Ascorbic acid was extracted in the presence of a metaphosphoric acid / acetic acid solution and assayed by standard vitamin C 2.6-dichlorophenol indophenols method (Poncracz et al., 1971).

The pH was determined at 25 °C. Using an ATC pH-Meter professional pH-013 according to the method described by AOAC (1990).

The total sugar content was determined according to the phenol-sulfuric method as described by Dubois et al. (1956)

Proteins were determined by the Kjedahl method (BIPEA, 1976).

The following minerals: Iron, Potassium, Sodium, Magnesium, Copper, Manganese and Zinc were assayed by a Varian Spectr AA-20 atomic absorption spectrometer using the AOAC 1990 method and Abulude et al. (2007).

1.3. Microbiological analyses

Microbiological analysis consisted of counting mesophilic aerobic germs. The count of these organisms was carried out on standard agar for counting, Plate Count Agar (PCA) according to the French standard V 08-051. (AFNOR, 1991). PCA

(Plate Count Agar) agar used for counting the total flora was cast into the Petri dish. The incubation was then carried out at 37 ° C. for 24 h after serial dilutions.

1.4. Sensory analysis

Samples of formulated drinks were analyzed by a panel of fifteen (15) members who are familiar with fruit juices. This panel is composed of students (women and men) from the National Polytechnic Institute of Yamoussoukro. The samples were evaluated using a scale from 0 to 10; with 0 for descriptor not perceived and 10 for descriptor extremely intense.

1.5. Statistical analysis

The statistical analysis was carried out by the software Statistica 7.1. Data were subjected to a one-way ANOVA, and means were compared by a Student Newman Keuls test with a significance threshold of 5%.

III. RESULTS

The results of Table 1 show the physicochemical composition of the various drinks based on cashew apples and pineapples, supplemented or not with aqueous extract of ginger and potassium sorbate.

TABLE 1
PHYSICOCHEMICAL CHARACTERIZATION OF CASHEW APPLE AND PINEAPPLE JUICE BLENDS PASTEURIZED OR SUPPLEMENTED WITH GINGER EXTRACTS OR POTASSIUM SORBATE (1g/kg)

	E0	EG2,5	EG10	EP	ES
Vitamin C (mg/100g)	54,38±3,12^{c}	64,34±10,38^{a}	78,68±3,29^{d}	46,9±2,74^{b}	64,34±2,19^{a}
pH	3,61±3,61^{b}	3,58±0,014^{a}	3,6±0,007^{c}	3,7±0,007^{d}	4,33±0,014^{e}
Total sugars (mg/100mL)	150,75±5,3^{ab}	220,5±4,24^{cd}	165,5±13,43^{b}	141,75±1,06^{a}	207,75±3,18^{c}
Proteins (%)	1,23±0,07^{a}	2,15±0,07^{c}	2,59±0,05^{d}	1,97±0,014^{b}	1,23±0,007^{a}
Mg^{2+}(mg/100mL)	888,6±4,52^{a}	872±2,54^{a}	907,3±8,06^{a}	728±1,69^{b}	913±64,62^{a}
K^{+} (mg/L)	1371,6±29,13^{a}	1227,3±3,25^{c}	1661,2±29,13^{b}	1370,3±8,9^{a}	1687,1±15,41^{b}
Ca^{2+} (mg/L)	306,3±9,47^{d}	282,2±0,28^{ab}	199±0,28^{c}	288,6±1,41^{b}	271,3±0,42^{a}
Fe^{2+} (mg/L)	3,08±0,1^{a}	2,92±0,12^{a}	3,77±0,48^{c}	2,06±0,04^{b}	2,89±0,08^{a}
P (mg/L)	26,5±0,7^{a}	65±2,12^{c}	105±1,41^{d}	25,5±0,7^{a}	59,5±0,7^{b}
Zn^{2+} (mg/L)	0,40±0,02^{b}	0,82±0,03^{c}	1,04±0,04^{d}	0,31±0,007^{a}	0,33±0,01^{a}

Means with different letters in the same row indicate significant differences (P≤ 0.05) (n=3). EO: control drink; E2.5: beverage supplemented with 2.5% aqueous extract of ginger; EG10: drink supplemented with 10% aqueous extract of ginger; EP: pasteurized drink; ES: beverage supplemented with potassium sorbate.

The ascorbic acid content varies from 46.9 mg/100 ml for the pasteurized drink (EP) to 78.6 mg/100 ml for the beverage preserved with 10% aqueous extract of ginger. The pH value varies from 3.58 for the sample EG2.5 (cashew apple and pineapple beverage supplemented with 2.5% aqueous ginger extract to 4.33 for sample ES (Beverage based on cashew apple and pineapple supplemented with potassium sorbate. There is a significant difference at P <0.05 between the different values of the total sugars of the different drink samples. The total sugars vary from 141.75 mg/ml for the EP sample (cashew apple and pasteurized pineapple drink without addition of aqueous extract or sorbate) to 220.5 mg/ml for sample E2.5. Protein content was significantly higher in the sample supplemented with 10% ginger, which ranged from 1.23% for sample E0 (cashew apple and pineapple beverage without addition of aqueous extract or Sorbate) to 2.59% for the E10 sample. Cashew apple and pineapple have varying concentrations of metal ions Mg^{2+}, K^{+}, Ca^{2+}, Fe^{2+}, Na^{+}, and Zn^{2+}. The cashew apple and pineapple drink supplemented with 10% aqueous ginger extract has higher iron, phosphorus and zinc contents.

Figure 1 shows the results in CFU/ml of the mesophilic aerobic germs counted on the first, fourth and seventh day of storage. These results show that the control sample exhibits an exponential increase in germs during the storage days compared to the treated drink samples. This microbial growth ranges from 4.4×10^{3} for the first day to 8.2×10^{5} for the seventh day of storage.

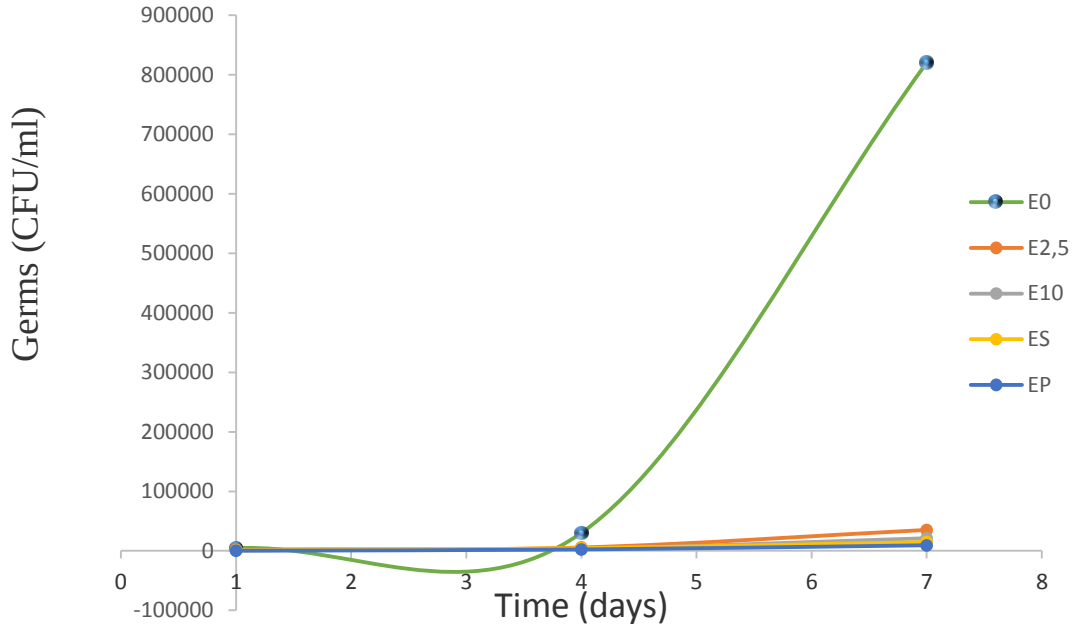

FIGURE 1: MESOPHILIC AEROBIC GERMS GROWTH OF VARIOUS CASHEW APPLE AND PINEAPPLE BLEND JUICES PASTEURIZED OR SUPPLEMENTED WITH AQUEOUS EXTRACT OF GINGER OR POTASSIUM SORBATE DURING STORAGE

EO: control drink; E2.5: beverage supplemented with 2.5% aqueous extract of ginger; EG10: drink supplemented with 10% aqueous extract of ginger; EP: pasteurized drink; ES: beverage supplemented with potassium sorbate.

The organoleptic properties of the beverages studied are presented in Table 2. From these results it emerged that the E10 sample had an overall acceptability of 7.2 against 5.5 for the sample E0.

TABLE 2

MEAN SENSORY EVALUATION SCORES OF THE VARIOUS CASHEW APPLE AND PINEAPPLE BLEND JUICES PASTEURIZED OR SUPPLEMENTED WITH AQUEOUS EXTRACT OF GINGER OR POTASSIUM SORBATE.

	Color		Fluidity		Appearance		Taste		Acceptability	
	day1	day7	day1	day7	day1	day7	day1	day7	day1	day7
E0	5,5^{a}	4,4^{a}	7,8^{a}	7,5^{a}	8,5^{a}	7^{a}	8,25^{a}	7^{a}	5,5a	4^{a}
E2,5	6,4^{a}	5,4^{a}	6,5^{a}	5,5^{a}	6^{a}	5,5^{a}	5,9^{a}	5,3^{a}	6^{a}	5,5^{a}
E10	7,7^{a}	6,7^{a}	6,3^{a}	5^{a}	6,9^{a}	6,3^{a}	6,3^{a}	5,3^{a}	7,2^{a}	6,5^{a}
ES	4,8^{a}	4,5^{a}	7,8^{a}	7,5^{a}	6,9^{a}	6,5^{a}	7,5^{a}	7^{a}	6,5^{a}	6^{a}
EP	5,5^{a}	4,8^{a}	7,5^{a}	7^{a}	6,5^{a}	6^{a}	7^{a}	6,5^{a}	6,2^{a}	6^{a}

Means with different letters in the same row indicate significant differences (P≤ 0.05) (n=3)

EO: control drink; E2.5: beverage supplemented with 2.5% aqueous extract of ginger; EG10: drink supplemented with 10% aqueous extract of ginger; EP: pasteurized drink; ES: beverage supplemented with potassium sorbate.

IV. DISCUSSION

The ascorbic acid contents of the different cashew apple and pineapple beverage formulations supplemented or not with aqueous extract of ginger or sorbate vary from 54.38 mg/100 ml for the formulation E0 to 78.68 mg/100 ml for the EG10 formulation. The beverage stabilized with 10% of the aqueous ginger extract had a significantly elevated ascorbic acid content ($P < 0.05$). Thus the ascorbic acid content can be increased by addition of the aqueous extract. This increase in the ascorbic acid content by addition of aqueous extract is comparable to the results of Yeo et al. (2014) on the analysis of the

quality attributes of a banana juice beverage supplemented with aqueous ginger extract. These results clearly show us that ginger spices are rich in ascorbic acid.

The protein content was significantly higher for the formulation containing the aqueous ginger extract. The 2.5% formulation contains 2.15% versus 2.59% protein for the 10% formulation of aqueous extract. These results are similar to those of Adesokan et al. (2005) and Olayemi et al. (2011). Ginger could be used to improve the vegetable protein content of fruit juice drinks.

The mineral contents evaluated show that the various formulations contain several minerals including magnesium, potassium, calcium, iron, phosphorus and zinc. The formulation of the cashew apple and pineapple beverage supplemented with 10% aqueous ginger extract has high levels of iron, phosphorus and zinc. These minerals are well known for their beneficial action on human organisms (Institute of Medicine, 2001).

The microbial load of the 10% aqueous ginger extract formulations increased from 1.2×10^3 on the first day to 2.1×10^4 germs on the seventh day. For the pasteurized formulation, this load increased from 200 germs to 2.3×10^3 compared to 4.4×10^3 to 8.2×10^5 germs for the sample without treatment (control) (E0). This rapid growth of germs is responsible for the spoilage of cashew apple and pineapple blend juices.

Mesophilic aerobic germs or total mesophilic aerobic flora are good indicators of the general quality and stability of products and the quality (cleanliness) of production facilities (Guiraud, 1998).

The samples supplemented with the aqueous ginger extract have lower microbial loads compared to the control sample E0. A decrease in germs was observed with increasing ginger concentration. The same result was observed in the pasteurized sample but this would decrease its content of thermosensitive elements. This loss would be detrimental to the nutritional quality of the formulation. Ginger may therefore have an antimicrobial effect which has helped reduce the microbial load of the cashew apple juice and pineapple supplemented with it. These results are comparable to those of several researchers (Smith-Palmer et al. 1998, Ayo et al. 2003, Omoya and Akharaiyi, 2012) on the stability of pineapple juice.

The sensory analysis of cashew apple and pineapple blend drinks shows that the formulation with 10% ginger extract has the highest acceptability. This could be explained by the spicy taste of that sample.

V. CONCLUSION

The results obtained in this study clearly indicate the potential of ginger to extend the shelf life of a cashew apple and pineapple blend beverage. Supplementation with 10% aqueous ginger extract could be a good preservative of fruit juice and beverage thanks to a better antimicrobial effect compared to the 2.5% aqueous extract. In addition, ginger could be used to boost the nutritional quality of tropical fruits drinks while increasing their shelf life. In addition to having satisfactory biochemical properties, ginger has organoleptic qualities popularly accepted. However, the practice of good hygiene during the preparation of beverages and fruit juices should be adopted to avoid significant microbial contamination.

DISCLOSURE OF INTEREST

The authors declare that they have no competing interest.

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Utilization of Marginal Soils with Application of Phosphorus and Ethephon for Sweet Corn (*Zea mays* L. *saccharata*) cultivation

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Abstract— *Abundance of marginal soils is among the major constraint to achieve high yield for crop production due to unsuitable physical and chemical properties of the soils. Commonly, farmers would manage the marginal soil by adding soil amendment, compost and fertilizer which increase the cost of production. Alternatively, application of fertilizer together with plant growth regulator (PGR) during crop management can be practiced to utilize the marginal soil effectively. The aim of this experiment was to determine effects of phosphorus (P) fertilizer and PGR namely ethephon on growth performance of sweet corn grown in three marginal soils namely Rasau, Kuah and Dampar. The treatments were arranged as factorial randomized complete block design with four rates of P fertilizer and standard rate of ethephon replicated four times. The results indicated that the physical properties of the marginal soils vary which Rasau dan Kuah series have low content of silt (10.30% and 36.10%), respectively and clay (9.40% and 11.86%) while Dampar series has low sand content (21%). Consequently, Dampar series depicted highest soil moisture content (18.80%) compared to Rasau and Kuah with high content of silt and clay at 42.43% and 36.43%, respectively. At tasseling stage, where application of P fertilizer with combination of ethephon at 0 and 15 kg P_2O_5 ha^{-1} there were significant difference between soil series on root length, total biomass wet and dry weight but exception for total biomass dry weight at 0 kg P_2O_5 ha^{-1}. Moreover, at 45 kg P_2O_5 ha^{-1} there were significant difference among soil series on leaf number and total biomass dry weight whereas at highest P rate of 60 kg P_2O_5 ha^{-1} only root length and root volume were affected. Most of the results were observed highest on Rasau soil series which contain highest sand particle instead of silt and clay compared to Kuah and Dampar series. However, the addition of ethephon and several P rates did not affect plant height among soil series. The results suggest that, the marginal soil can be utilized for sweet corn production by addition of combined P fertilizer at low rate and PGR.*

Keywords— Zea mays L. saccharata, marginal soil, phosphorus, ethephon, plant growth.

I. INTRODUCTION

Marginal soil for agriculture is characterized by soil which is poor in soil physical and chemical properties. These aspects play an important role for crop production in terms of growth performance and yield. The soil properties of each soil type may varies due to several factors such as parent material, topography, climate and agricultural practices. According to Shamsuddin and Markus (2008), most of the Malaysian soils are known as Oxisols, acidic in nature and developed from a range of parent materials which are dominated by kaolinite and oxides of iron (Fe) and aluminium (Al) (sesquioxides). The availability of Al and Fe in most acid soils would fixed soluble inorganic phosphorus (P) that subsequently affect availability of P for plant growth (Adnan *et al.*, 2003). Yang *et al.* (2014) stated that P is an element essential for plant growth, fruit set, fruit development and fruit ripening and can be deficient or unavailable in agricultural soils.

As alternative, application of P fertilizers could overcome the problem so that the marginal soils can be used for cultivation and better yield production can be achieved. Furthermore, crop responses to fertilizer application are indirectly affected by soil physico-chemical properties where different soil texture will have diverse capability to hold plant nutrient. Application of P fertilizer in clay loam soil texture significantly increased dry matter yield, yield components and growth parameters of common bean (Taruko and Mohammed, 2014) whereas Wulan and Prijono (2013) in their study of different dry-land types concluded that factors influencing water infiltration are soil type, soil organic matter, porosity, bulk density, specific gravity and initial soil moisture content. Indeed, the proportion of sand, silt and clay in soil is so vital to the suitability of the soil for agriculture production in terms of water infiltration, soil moisture and nutrient retention.

Plant growth regulator namely ethephon (2-chloroethyl-phosphonic acid) is a systemic plant growth regulator that can be use directly either by soil drenching or foliar application to the plant. It will penetrate into plant tissue and decompose to ethylene, chloride ion and phosphonic acid (Bhat et al., 2010). At present, ethepon is widely used for specific function such

as to hasten fruit ripening, stimulate flowering emergence and improve plant resistant to lodging. Ethephon treatment resulted in a significant reduction of corn plant height which was attributed to decrease in internode length (Mischeck and Fanuel, 2014). Moreover, ethephon will breakdown to release ethylene that will be involved to enhance root growth in soil with low nutrient concentration such as nitrogen, phosphorus and potassium (Postma and Lynch, 2011).

In order to utilize the marginal soils for crop production, proper crop and nutrient management should be adjusted according to the soil condition so that plant requirement will be sufficient to complete their cycle. Consequently, combined application of P fertilizer and ethephon to marginal soil would be a promising approach to improve crop growth performance. Therefore, the combined effect of ethephon and several rates of P application on growth performances of sweet corn (*Zea mays* L. *saccharata*) grown in three marginal soils were investigated.

II. MATERIALS AND METHODS

The sampling area was located at Fruit Research Centre, Malaysian Agricultural Research and Development Institute (MARDI) Sintok, Kedah (6°29'17.8" N, 100°29'00.8"E). The marginal soils series namely Rasau, Dampar and Kuah were collected at 0-20 cm by using stainless steel auger. The soil samples were air-dried before ground to pass through a 2.0 mm sieve. About 15 kg of each marginal soil were packed into a 40cm x 40 cm polybag before sweet corn hybrid (Leckat seed) at vegetative 2 stage (V2) were transplanted. The experiment was conducted in a factorial randomized complete block design (RCBD) with four replications. Four phosphorus (P) levels were 0, 15, 45 and 60 kg P_2O_5 ha^{-1} and standard recommendation of Ethephon at 270 ppm was applied once to all treatments (200mL per polybag) by soil drench technique at critical vegetative stage development of sweet corn which was vegetative stage 5 (V5) or at 20 days after transplanting (Souza et al., 2016). The nitrogen (N) and potassium (K) were fixed at 120 kg N ha^{-1} and 90 kg K_2O ha^{-1} for all treatments. Plant maintenance such as pest and diseases control followed standard procedure for sweet corn cultivation. Weed control was done manually when necessary. The seedlings were irrigated manually twice daily until field capacity level. The data collection was carried out during planting until tasseling (45 days after transplanting). Data of soil nutrient contents of the marginal soils were shown in Table 1.

TABLE 1
THE NUTRIENT CONTENTS OF THE MARGINAL SOILS BEFORE THE EXPERIMENT AND METHODS USED FOR NUTRIENT DETERMINATION.

Soil properties	Soil series			Method/Extractant
	Rasau	Kuah	Dampar	
pH	5.19	5.19	4.77	Soil : water 1:2.5
Carbon (C), %	0.08	0.06	0.07	Combustion TruMac CNS analyzer, LECO
Nitrogen (N), %	0.67	0.77	0.73	
Phosphorus (P), mg kg^{-1}	45.22	71.15	39.48	Bray and Kurtz II, 1945
Potassium (K), cmol (+) kg^{-1}	0.11	0.20	0.11	Sumner and Miller, 1996 Ammonium acetate
Calcium (Ca), cmol (+) kg^{-1}	3.77	2.60	0.68	
Magnesium (Mg), mg kg^{-1}	1.14	0.69	0.35	
Mangenese (Mn), mg kg^{-1}	0.99	0.76	0.79	Reed and Martens 1996 Mehlich-1 (Double acid)
Cuprum (Cu), mg kg^{-1}	70.40	89.90	111.80	
Zink (Zn), mg kg^{-1}	57.55	25.43	25.74	
Iron (Fe), mg kg^{-1}	32.30	22.25	28.20	Bertsch and Bloom, 1996 Potassium chloride
Alumium (Al), mg kg^{-1}	13.63	45.10	21.96	

Three soil samples were taken randomly for each soil series for physical analysis which were soil color, soil pH, soil texture, soil bulk density, total porosity and soil moisture. The soil color was compared visually by using Soil Munsell Color Chart. The soil proportion of silt, clay and sand of the soils to reflect the soil texture were determined by using pipette method (Day, 1965) and referred to USDA soil classification triangle for soil type determination. The bulk density of the soils were measured using the core method while pycnometer method was used for soil particle density analysis (Blake and Hartge, 1986). The soil cores were collected and weighed for wet and oven dry before the bulk density of the soil samples were calculated from the ratio of mass of dry soil per unit volume of the core sample after samples were oven–dried at 105°C for

24 hours. The soil moisture content was determined by using gravimetric method where the moisture content was in percent and calculated as the mass of moisture in the soil sample divided by the mass of the dry soil. The total porosity of each soil samples was calculated from bulk density and particle density values by using the following equation (Brady and Weil 2010):-

[1-(bulk density/particle density)] x 100

Agronomic data measured at tasseling (45 days) were number of leaves per plant, plant height, total root length, root volume, total wet biomass and total dry biomass. The leaf, stem and root were harvested and cleaned before the measurements were taken. The data were analysed using Statistical Analysis Software 9.1.3 (SAS Institute Inc) by using Duncan Multiple Range's Test (DMRT) for mean comparison at $p \geq 0.05$.

III. RESULTS AND DISCUSSION

3.1 Soil colour of the Rasau, Kuah and Dampar series

The colour of each soil series was mostly grouped as brown in colour except for Kuah as dark yellowish brown (Table 2). The differences in colour of soil are subjected to several factors such as biological decomposition, chemical reaction and soil parent materials. At upper soil depth, the soil colour is often dark in colour, due to partially decomposed organic matter compared at lower soil depth. Brady and Weil (2010) stated that the amount of proteins or specific minerals present in the soil influenced the soil colour. Yellow or red soil indicates the presence of iron oxides while manganese oxide causes a black colour, glauconite or iron potassium phyllosilicate makes the soil green and calcite can make soil in arid regions appear white. The information on soil colour is an important indicator of the soil conditions in term of soil moisture and mineral content which reflect soil fertility status of the soil for plant growth.

TABLE 2
SOIL COLOUR OF THE RASAU, KUAH AND DAMPAR SOILS AT 0-20cm SOIL DEPTH.

Soil series	Soil color chart	Soil color	Image
Rasau	10 YR 4/3	Brown	
Kuah	10 YR 3/4	Dark yellowish brown	
Dampar	7.5 YR 4/4	Brown	

3.2 Comparison of soil texture, bulk density, particle density, porosity and soil moisture

The soil particle analysis showed similar trend on the proportion of sand, silt and clay present in the three marginal soil where sand > silt> clay except for Dampar with silt> clay> sand (Table 3). The Rasau soil contained higher proportion of sand particles followed by Kuah and Dampar whereas Dampar was observed to contain higher proportion of silt and clay as compared with Kuah and Rasau. Overall, Kuah showed intermediate percentage of sand, silt and clay between Rasau and Dampar soils. The different percentage of the soil particle caused the soil texture of the marginal soil to be dissimilar. The soil texture is crucial in terms of soil chemical and physical properties. Fraga et al. (2014) stated that soil texture class of any

soil type presents its own properties in terms of agricultural applicability and affects the movement and availability of air, nutrients and water in a soil.

The results depicted that Kuah soil series has better soil texture compared with Rasau and Dampar due to the intermediate proportion of sand, silt and clay and was categorised into loam soil texture which could provide good aeration for root growth, drainage and nutrient holding capacity. Furthermore, Rasau soil texture is grouped into loamy sandy as sand particle is predominant as high as 80% with average ±10% silt and clay. Therefore, Rasau soil expected to provide good aeration to the plant roots, good for drainage and favourable nutrient uptake with consideration of sufficient soil moisture but disadvantages with high percentage of sand on Rasau soil, the soil likely to have low water retention and nutrient holding capacity. Moreover, this study revealed that Dampar soil texture is clay loam with low in sand percentage (21%) but intermediate silt and clay percentage around 42% and 36%, respectively (Table 3). It indicated that Dampar soil has high risk of water logging condition due to poor drainage system even though it has higher proportion of clay which would improve nutrient and water availability. According to Moges *et al.* (2013) the soil textural fractions varied with land use, while silt, clay and bulk density differed with soil depths but the soil pH did not show any significant variation across land use types or soil depths.

TABLE 3
THE PROPORTION OF SAND, SILT, CLAY AND SOIL TEXTURE OF THE RASAU, KUAH AND DAMPAR SOIL SERIES.

Soil series	Sand	Silt	Clay	Texture
	%			
Rasau	80.30 a	10.30 c	9.40 c	Loamy sand
Kuah	52.00 b	36.10 b	11.86 b	Loam
Dampar	21.14 c	42.43 a	36.43 a	Clay loam
**** Means with similar alphabet are not significantly difference at p ≥ 0.05 by Duncan multiple range's test (DMRT).***				

Different soil texture of the soils also affected the bulk density, particle density, porosity, and soil moisture (Table 4). The soil with higher bulk density value would have low porosity value and vice versa. The porosity will influence soil water retention including soil moisture, which is related with the availability of oxygen to the plant roots. It was observed that Dampar soils have greater physical properties and capable to retain about 18% of soil moisture followed by Rasau and Kuah at 13 and 11%, respectively. Rasau and Kuah soils showed similarity in term of bulk density properties as both of the soil contain high sand particle and at the same time there was significant difference in term of soil moisture as generally about 50% of the soil component are filled with air and water other than organic matter and soil particle. Soil with high sand particle have less total pore space and relatively have high bulk density compared with silt and clay soil. Nunes *et al.* (2016) claimed that soil densities higher than 1.21 Mg m^{-3} were limiting for corn root dry matter production in the layer of 0.2-0.3 m and total of roots dry matter grown in Oxisol soil type that has of high proportion of sand (549 g kg^{-1}) and clay (367 g kg^{-1}).

TABLE 4
THE BULK DENSITY, PARTICLE DENSITY, POROSITY AND SOIL MOISTURE OF RASAU, KUAH AND DAMPAR SOIL SERIES.

Soil series	Bulk density	Particle density	Porosity	Soil Moisture
	g cm^{-3}		%	
Rasau	1.87 a	2.36 b	20.50 b	13.51 b
Kuah	1.86 a	2.36 b	20.93 b	11.78 c
Dampar	1.68 b	2.40 a	30.10 a	18.80 a
**** Means with similar alphabet are not significantly difference at p ≥ 0.05 by Duncan multiple range's test (DMRT).***				

3.3 Effects of different levels of P fertilizer on plant and root growth of sweet corn

The aboveground and root performance of sweet corn grown in three marginal soils were listed in Table 5. After application of P fertilizer at several rates with ethephon showed that there were significant differences on plant and root growth data among the soils. At zero and 15 kg P_2O_5 ha^{-1}, there were significant differences on root length and total wet and dry biomass weight, respectively, with the exception at zero P application for total dry biomass weight. Meanwhile at 45 kg P_2O_5 ha^{-1},

only leaf number and total dry biomass weight were significant. Furthermore, both root length and root volume of the sweet corn were observed significant at 100% P fertilizer recommendation which is 60 kg P_2O_5 ha^{-1} but has no effect on leaf number, plant height and total wet and dry biomass among the soil series. The results revealed that application of ethephon with P fertilizer at 45 kg P_2O_5 ha^{-1} affected the leaf number of sweet corn but not the plant height in term of aboveground part grown on the marginal soils which vary physical soil properties. This result concurred with that of the application of 10-40 kg P ha^{-1} that has no significant effect on plant height of common bean grown in clay loam soil (Turuko and Mohammed, 2014). In comparison to root performances the ethephon application shown significant results at all P fertilizer rates but not at 45 kg P_2O_5 ha^{-1}. It revealed that ethephon application together with P fertilizer at low rate probably has improved the number of leaves of sweet corn grown on deprived Rasau soils texture compared to Kuah and Dampar.

The differences observed on root performance and total biomass weight in this study were probably due to the differences in the soil pH, soil physical and chemical properties and interactions of P fertilizer with the soil. The pH of Dampar soil was recorded at 4.77 but 5.19 for both Rasau and Kuah soil series (Table 1). The findings of this study indicated that Dampar soil is more acidic compared with Rasau and Kuah soil series. Thus it was observed that the root growth was significantly affected by the acidic soil pH condition. Zu *et al.* (2014) also indicated that low soil pH at 3.5 may directly inhibit root development and reduce seedling growth of black pepper (*Piper nigrum* L.). Furthermore, different soil texture of the marginal soils also influence the root growth as the proportion of sand, silt and clay has effect on soil bulk density which is related in root penetration capability. The bulk density for Rasau, Kuah and Dampar soil series were 1.87, 1.86 and 1.68 g cm^{-3}, respectively suggested that resistance to root penetration may be increased and thus limit the root growth. Keisuke *et al*. (2015) recorded a reduction of 50% in soybean root growth at bulk density values of 1.82 Mg m^{-3} and 1.75 Mg m^{-3} for sandy loam and sandy clay loam. Moreover, P is the nutrient that is most affected by soil pH but at the same time the effect of P fertilization may also vary depending on the balance of other nutrients present (Grant *et al*., 2005). The results showed that at 15 and 45 kg P_2O_5 ha^{-1} the sweet corn grown in Rasau soil gave higher high total dry biomass compared with Kuah and Dampar soil series. The results could be associated with the soil texture of Rasau that contained the highest proportion of sand which provide better root penetration for nutrient uptake, particularly P. The findings by Mazengia (2011) also reported that P enhanced root development and increased total dry biomass of maize that was grown in well-drained kaolinitic clayey soils.

TABLE 5
GROWTH PERFORMANCE OF SWEET CORN AT 45 DAYS AFTER PLANTING AT DIFFERENT P LEVELS.

P rates	Soil series	Leaf number	Plant height	Root		Total biomass weight	
				Length	Volume	Wet	Dry
kg P_2O_5			cm		mL	g	
0	Rasau	12 a	117.63 a	77.00 a	45.00 a	232.50 a	74.39 a
	Kuah	12 a	106.75 a	65.25 ab	53.75 a	195.50 ab	68.03 a
	Dampar	11 a	107.50 a	42.50 b	38.75 a	176.75 b	66.89 a
		n.s	n.s	**	n.s	**	n.s
15	Rasau	11 a	118.88 a	86.13 a	50.00 a	238.00 a	74.50 a
	Kuah	12 a	106.50 a	72.00 ab	52.50 a	198.50 b	66.92 b
	Dampar	11 a	97.38 a	38.00 b	43.25 a	164.25 b	63.03 b
		n.s	n.s	**	n.s	**	**
45	Rasau	13 a	111.88 a	89.13 a	37.50 a	207.75 a	70.35 a
	Kuah	12 ab	100.25 a	74.25 a	46.50 a	173.50 a	62.96 b
	Dampar	11b	95.00 a	68.15 a	43.75 a	162.50 a	62.20 b
		**	ns	ns	ns	ns	**
60	Rasau	12 a	104.00 a	53.50 a	30.00 b	202.75 a	69.67 a
	Kuah	12 a	103.50 a	63.43 a	50.00 a	201.50 a	68.91 a
	Dampar	12 a	99.88 a	33.38 b	42.50 ab	192.75 a	59.64 a
		n.s	n.s	**	**	n.s	n.s

**** Means with similar alphabet at each P rates in a column are not significantly difference at p ≥ 0.05 by Duncan multiple range's test (DMRT).***

IV. CONCLUSION

The soil color of Kuah and Dampar were recorded as brown and dark yellowish brown for Kuah indicated these soils were less in organic matter with carbon content range from 0.06-0.08%. The results depicted that the marginal soil namely Rasau soil series has poorer soil texture as compared with Kuah and Dampar but with application of P fertilizer at low rates and ethephon, number of leaves and roots performances were improved for sweet corn. The growth performance of sweet corn were significant in term of number of leaves, root length and root volume including total biomass weight wet and dry but no effect of ethephon was recorded on plant height. As conclusion, in order to improve the potential of these three marginal soils for plant and root growth, application of P fertilizer with ethephon as low as 15 kg P_2O_5 ha^{-1} up to 45 kg P_2O_5 ha^{-1} for sweet corn is certainly an important aspect to consider.

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Evolution of the fruit market in the city of Lavras-Minas Gerais-Brazil

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Abstract*—Fruit growing has achieved advances through the use of new technologies generated by research. In Brazil, it is one of the most prominent sectors in agribusiness, achieving significant results and generating business opportunities. In this way, the fruit market has grown considerably in the last decades, both in quantity and in quality. Allied to this, the changes in consumer behavior regarding food consumption has been responsible for the increase of the fruit market. The objective of this work was to know the evolution of the fruit trade in the city of Lavras, state of Minas Gerais, Brazil, in relation to the quantity sold, monetary value, losses in the gondolas of retail establishments and per capita consumption of the population of this city.*

Keywords – Market, Fruits, Consumption, food, Brazil.

I. INTRODUCTION

Fruticulture is one of the most prominent sectors of Brazilian agribusiness. Through a wide variety of crops, produced all over the country and in different climates, fruit production achieves significant results and generates opportunities for Brazilian agribusiness. Brazil is the third largest producer of fruit in the world, behind only China and India, which shows the sector's relevance to the Brazilian economy, with 38.36 million tons produced in 2013, behind only China, with 137.6 million tons, and India, with 71.07 million tons (AGRONEGÓCIO, 2015).

Brazilian production is focused on tropical, subtropical and temperate fruits, thanks to its territorial extension, geographical position, soil and climatic conditions. According to the IBRAF (2013), fruit growing in Brazil occupied an area of 2.2 million hectares, moved US$5.5 billion and employed 5.6 million people, representing 27% of the agricultural labor force from the country.

In this way the fruit market has grown considerably in the last decades, both in quantity and in quality. This was possible because of advances in research and development in the sector. In four decades, Brazil has passed from importer to exporter of some temperate fruits, such as apple. In the 1970s, the national production of this fruit represented only 10% of domestic consumption. Today, there are over 36,000 hectares producing high-quality apples, enough to serve the domestic market and even export (ANDRADE et al., 2012ab).

In addition to this, changes in consumer behavior regarding food consumption have been responsible for the increase in the fruit market (PIMENTEL; PIMENTEL, 2011).

Faced with this trend, the Center for Advanced Studies in Applied Economics, University of São Paulo (Cepea-USP), conducted a survey on fruit consumption in Brazil, where there was an average increase of approximately 4.38 kg per person per year, from 2005 to 2011 (SILVEIRA et al., 2011).

The objective of this work was to know the evolution of the fruit trade in the city of Lavras - MG - Brazil, in relation to the commercial volume, monetary value, percentage of losses in the gondolas and per capita consumption of fruits of the population.

II. MATERIAL AND METHOD

This research was carried out in three stages in the city of Lavras - MG - Brazil, the first in the months of August to July 2004/2005; The second in the months of August to July 2011/2012, and the third in the months of August to July 2014/2015, in the various networks of supermarkets, saloons and free-trade fairs.

The data collection was performed monthly, through a spreadsheet with questions about quantity sold, total value of consumer prices and percentage of losses in gondolas. The data collected were tabulated and analyzed monthly.

The sampling of the number of establishments interviewed was carried out according to the criteria of Cochran (1965), in which locality with more than fifty commercial establishments the sample is 10%, ten to forty of 20% and less than ten of 100%. For this research carried out in the city of Lavras, Minas Gerais, Brazil, the sample was 100% of the four networks of supermarket establishments and ten retail establishments (Greenery).

III. RESULT AND DISCUSSION

According to the data presented in Figure 1, in the first stage (2004/2005), an average of 377.6 t of fruits per month was traded, moving around US$ 197,030.00, with a price Average of US$ 0.52 per kg of fruit.

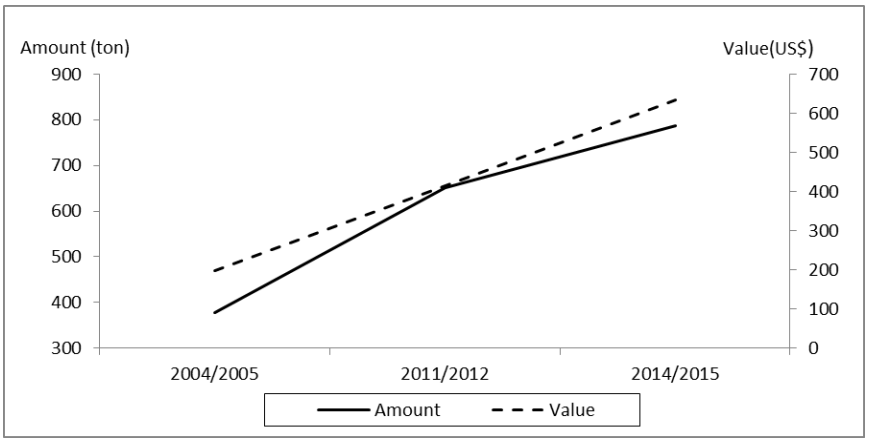

FIGURE 1 - QUANTITY (T) AND VALUE (US$) OF FRUITS TRADED IN LAVRAS FROM AUGUST TO JULY OF THE 2004/2005, 2011/2012 AND 2014/2015 PERIODS.

In the second phase (2011/2012), there were 650.8 t of fruits per month, moving US$ 414,010.00 monthly, with an average price of US$ 0.63 per kilo (ANDRADE et al., 2012a).

Finally, in the third stage, this average rose to 786.3 t monthly, moving US$ 634,890.00, per month at an average price of US$ 0.80 per kilo of fruit.

According to the data presented, evolution of 72.35% from the first to the second stage and 108.23% from the first to the third stage, clearly shows the trend of increase in fruit consumption by the population, mainly motivated Aspects related to health and the search for a better quality of life.

In the last six years, the per capita consumption of fruit in Lavras rose from 47.76 kg / inhabitant / year to 58.90 kg / inhabitant / year (ANDRADE et al., 2012ab). In that interval, consumption per capita had an increase of 11.14 kg per person per year, which was more than twice the average in Brazil, where there was an increase of 4.38 kg per person per year, according to Data published by Cepea-USP (SILVEIRA et al., 2011).

Comparing the evolution from the first to the third stage, per capita consumption increased from 47.76 kg / inhabitant / year (ANDRADE et al., 2012b) to 78.63 kg / inhabitant / year, representing an increase of 30, 87 kg / hab / year, ie an increase of 64.63% in per capita consumption.

The per capita consumption in 2010 in Brazil was 57.00 kg / hab / year, in Italy, 114.00 and in Spain, 120.00 kg / hab / year, according to FAO (2015).

In Lavras, although per capita consumption is higher than the national average, it is still below that observed in Italy and Spain (ANDRADE et al., 2012a). This fact can be explained by the increase in the supply of fruits in the retail market, as a consequence of the increase in the demand for the population, due to the behavioral changes of the population that started to look for healthier foods, together with an improvement of the purchasing power of the society in general , As well as the improvement of the supply and distribution of these products by the retail network with assiduity and punctuality.

The losses of the fruits in supermarket gondolas and sweets, went from 7.8% (ANDRADE et al., 2012a), in the first stage, to 4.6% in the third stage, according to the report of the responsible for the hortifrúti section of the researched establishments. There was a reduction in losses from 64.24 to 40.48 t / month, or 23.76 t / month less, representing a saving in waste of R $

57,261.50 per month. This is due to the efforts made by the management of Central of Supply of the State of Minas Gerais - CeasaMinas in the logistics of distribution to the final consumer.

Table 1 shows the data of the main fruits commercialized in the city of Lavras, MG, in the third stage of this research.

TABLE 1
MOST MARKETED FRUITS (T) IN LAVRAS - MG, BRAZIL, FROM AUGUST 2014 TO JANUARY 2015

Fruit/Month	Aug/14	Set/14	Oct/14	Nov/14	Dec/14	Jan/15	Average
Silver banana	92,79	109,66	109,93	102,24	104,72	94,38	102,29
Banana nanica	28,29	27,09	33,30	32,79	47,85	53,46	37,13
Orange pear	105,85	109,66	121,90	97,99	92,13	94,60	103,70
National apple	44,52	41,29	56,05	33,87	59,30	35,44	45,08
Papaya formosa	19,50	24,29	19,37	15,86	13,73	21,50	19,04
Papaya amazonas	15,01	18,70	16,37	20,15	16,14	22,34	18,12
Pear pineapple	20,86	18,92	18,72	24,01	30,60	18,29	21,90
Pink grape	-	-	-	-	26,14	-	-
Manga palmer	-	-	-	-	-	26,52	-
Sub-total*	326,82	349,58	375,64	326,91	364,47	340,01	347,24
others	419,28	433,32	435,16	433,49	467,93	445,39	439,10
TOTAL	746,00	782,90	810,80	760,40	832,40	785,40	786,34

* ***Subtotal for banana, orange, apple, papaya and pineapple***

The banana is the most commercialized fruit, with a monthly average of 139.42 t, of which the cultivar Silver contributes 102.29 t and Nanica, with 37.13 t.

The second most traded fruit is the 'Pêra' orange, with a monthly average of 103.70 t, followed by the national apple with 45.08 t and the papaya with 37.16 t, being 19.04 t of the papaya 'Formosa', and 18.12 t of the 'Amazonas' papaya.

In December 2014, the 'Rosada' grape was the 5th placed, with 26.14 t, and in January 2015, this position was occupied by the 'Palmer', with 26.54 t.

In the three steps surveyed, it is verified that the month of December was the month of greatest fruit supply in the city of Lavras. It can be said that this event is due to the greater supply of fruits, accompanied by the greater demand of fruits by the population, a factor motivated by the Christmas festivities and also by the increase of income, with the receipt of the 13th salary.

As for the increase in the volume of marketed fruit, it can be said that it is a consequence of the increase of productivity and quality, as well as the constant supply of these products during all months of the year. This offer, in turn, is provided by the technological development resulting from the results of continuous scientific research, which has made possible the advancement of fruit growing in the various geographic regions of the State of Minas Gerais and Brazil.

IV. CONCLUSION

The commercialization of fruit in Lavras has increased simultaneously to the increase of the consumption and the supply of fruits with quality, assiduity and punctuality;

The average price of fruit has also increased, in line with inflation;

Losses in facilities decreased as a result of more efficient distribution logistics;

Technological development has provided better quality fruit during all months of the year, favoring increased consumption, which has also been driven by changing consumer habits.

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Technical Efficiency of Soya Beans Production in Mubi North Local Government Area of Adamawa State, Nigeria

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Abstract— *The study was conducted to evaluate the technical efficiency of soya bean production in Mubi North Local Government Area of Adamawa State, Nigeria. The objective of the study was to examine the inputs and output relationship of soya bean production in the study area. A multi stage random sampling techniques was used to select 80 respondents in the study area who were noted for soya beans production. Primary data were collected from the respondents with the aid of structured questionnaire and were analyzed using stochastic frontier function. It was therefore recommended that inputs such as seeds, fertilizers and agrochemicals which were the major inputs that increase the output of soya bean production in the study area should be made available on time, in right amounts and at affordable prices to the farmer's stakeholders in agriculture. Proper orientation and knowledge should be given to people willing to go into the cultivation of soya beans on the appropriate time of planting. Extension services should also be rendered effectively*.

Keywords— Soya Beans production, Adamawa state, Nigeria, Mubi north, Nigeria.

I. INTRODUCTION

The agricultural sector in Nigeria has suffered many reversals during the past couple of decades. From era of booming of export trade in agricultural commodities, the Nigerian agricultural sector has degenerated to an import dependent one (Ojo and Ehinmowo, 2010). Subsequently, it has failed to generate significant foreign exchange, feed agro-allied industries, improve the living standards of farming households and rural dwellers and provide effective demand for industrial goods and services. Increasing food production however is vital for enhancing future food security in the country as this is no longer debatable but a necessity. To achieve this, good knowledge of the current efficiency or inefficiency inherent in the crop production sub-sector as well as factors responsible for the level of efficiency and inefficiency must be critically examined.

Soya bean is the richest source of plant protein known to man (Odusanya, 2002). It is also an important source of income. It can contribute to the enhanced sustainability of intensified cropping system by improving soil fertility through nitrogen fixation, permitting a longer duration of ground cover in the cropping sequence and providing useful crop residues for animal feed. Nigeria is still ranked amongst the lowest soya beans producing countries in the world (Faostat, 2009). This can be attributed to poor and inefficient usage of resources by farmers. Resource use efficiency study is very important for increased output and profitability of farmers. It is widely held that efficiency is at the heart of agricultural production. This is because the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (Udoh, 2000). For these reasons, efficiency has remained an important subject of empirical investigation particularly in developing economies where majority of the farmers are resource-poor. These problems identified have given rise to the following research questions.

II. METHODOLOGY

2.1 Description of the Study Area

This study was conducted in Mubi north local government area of Adamawa state. Mubi North local government of Adamawa state lies on the west bank of the Yedseram River, a stream that flows into Lake Chad and is situated on the western flanks of the Mandara Mountain. It shares common boundaries with Borno State to the North Hong Local Government Area to the West, Maiha Local Government to the South and Cameroun Republic to the East.

Temperature is normally warm to hot with minimum temperature of 120c and maximum temperature of 370c (Adebayo, 2004). The ethnic groups are mainly Fali, Gude, Marghi and Fulani. The inhabitants are predominantly farmers and traders.

Mubi is the capital of Mubi North Local Government Area of Adamawa State in Nigeria. It lies on latitude 10º 32 N to 10º 11 N and longitude 13°12 E to 13°35'E, with a total land mass of 506.4Km2 and a population size of 759,045 people. Mubi has a tropical climate which is determined by the movement of the Inter Tropical Convergence Zone (ITCZ), as well as the effect

of relief (Ray, 2007). Rainfall begins in April, progressing and reaching its peak in July/August and stops most of the time in October. Average annual rainfall ranges between 998 mm and 1262 mm. The areas just below the Mandara Mountains record the highest rains. Rainfall intensity is high with rainy days making up to 87 % of the days with more than 20 mm of rainfall (Ray, 2007). Alongside air and water, soil is another vital resource that provides the basis for human living (Adebayo, 2004). The soil is composed of weathered rock materials (parent material), organic matter, moisture content, and dissolved minerals in the air (Adebayo, 2004). Thus, it forms a very important medium for plant growth. However, soils vary in their texture, structure, colour, mineral content and moisture holding capacity (Adebayo, 2004). Some of these physical properties collectively form the basis for their classification.

The soil of Mubi regions therefore, fall under the category of ferruginous tropical soils of Nigeria based on the genetic classification made by the Food and Agricultural Organization of the United Nations (Adebayo, 2004).

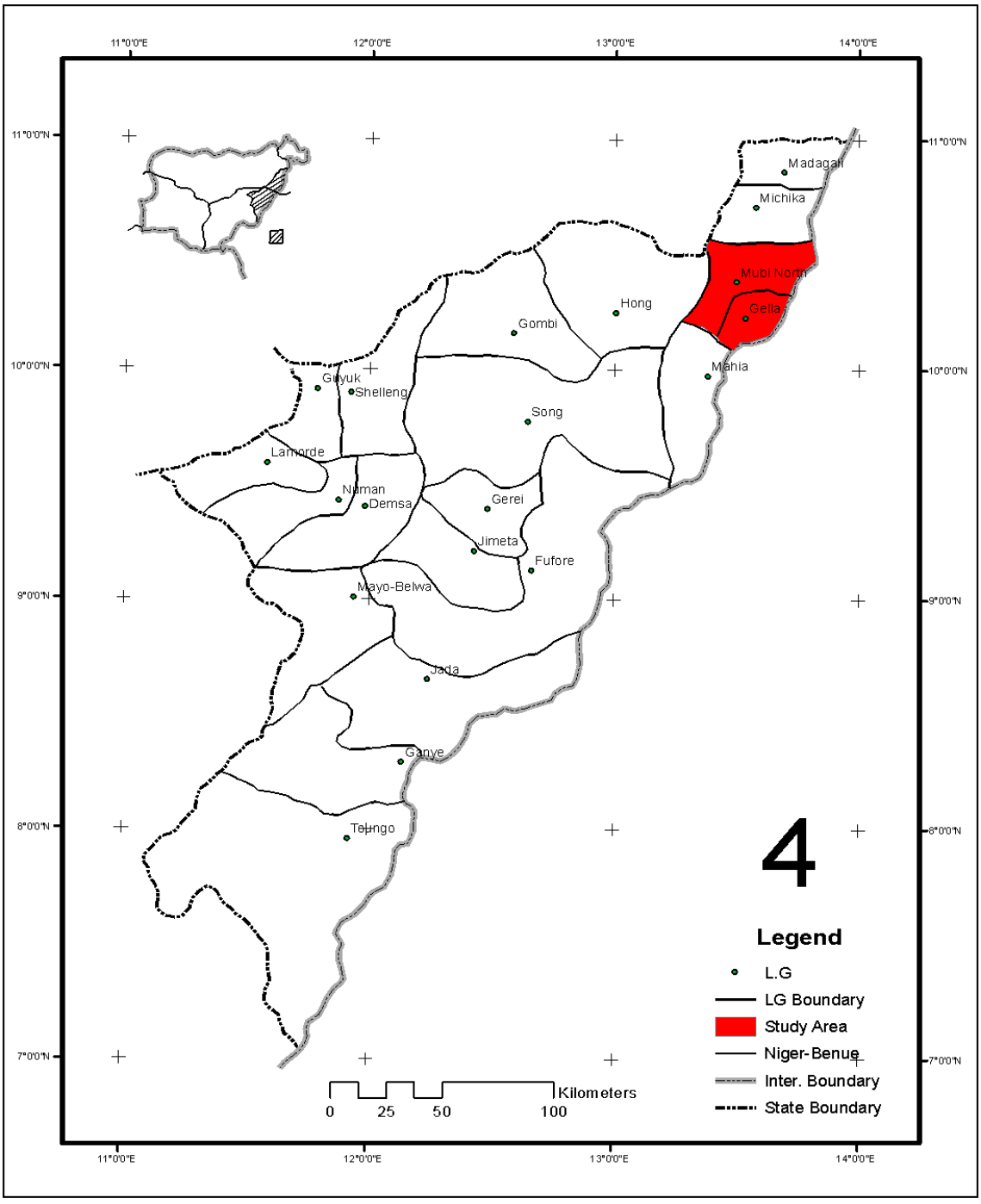

FIGURE 1: MAP OF ADAMAWA STATE, SHOWING A PORTION OF MUBI NORTH LOCAL GOVERNMENT

2.2 Sources of Data and Sampling procedure

Data for this research was collected from primary sources, using structured questionnaires. The questions were being structured to elicit answers on the objectives of study.

Based on the study, the population targeted was soya bean farmers in the study area (Mubi north, LGA) of Adamawa State. Mubi north comprises of four (4) districts (Mubi-Town, Bahuli, Mayo-Bani and Muchalla) out of which it is divided into eleven (11) political wards namely; Mijilu, Lokuwa, Mayo-Bani, Kolere, Digil, Yelwa, Vimtim, Muchalla, Bahulli, Sabon-layi and betso. The multi-stage random sampling techniques was used in selecting the respondents, out of the population, four wards werechosen from the local Government area that were noted for soyabean production from which 20 farmers were selected from each ward to make a total number of 80 respondents.

2.3 Analytical Techniques

The analytical tool that was used in achieving the objective of the study was Stochastic Frontier Function Cobb-Douglas production frontier function was estimated using the Maximum Likelihood Techniques. These two frontiers are the basis for deriving farm level efficiency measures. The stochastic production frontier was written as:

$$\text{Ln } Y_i = \ln\beta_0 + \sum^{s}_{i} = {}_1\beta_j \ln X_{ij} + vi - \mu_i \quad (3)$$

Where:

ln = the natural logarithm

Yi = Farm output (kg)

Xij = Vector of farm inputs (X1 – X5) used

X1 = Farm Size (hectare)

X2 = Quantity of seeds (kg)

X3 = Fertilizer (kg)

X4 = Total Labour used (man hours) and

X5 = Volume of Agrochemicals (litre)

v = random variability in the production that cannot be influenced by the farmer;

μ = deviation from maximum potential output attributable to technical inefficiency.

βo = intercept;

βi= vector of production function parameters to be estimated;

i = 1, 2, 3, n farms;

j = 1, 2, 3, m inputs.

The inefficiency model it is specified as:

$$ui = \delta0 + \delta1Z1 + \delta2Z2 + \delta3Z3 + \delta4Z4 + \delta5Z5 + \delta6Z6 \quad (4)$$

Where,

ui = technical inefficiency effect of the ith farm;

Z1 = educational level of farmer in years of formal education completed;

Z2 = household size (no.);

Z3 = age of farmer in years;

Z4 = farming experience in years

Z5 = membership of cooperative society

δ0 = constant

δ1 – δ6 = parameters to be estimated.

The ß and δ coefficients are un-known parameters to be estimated along with the variance parameters δ2 and γ. Aigner et al. (1977), Jondrow et al. (1982), and Green (1993) defined δ2 and λ as:

$$\delta 2 = \delta 2v + \delta 2u \text{ and } \lambda = \delta u/ \delta v \quad (5)$$

Battese and Corra (1977) defined γ as total variation of actual output towards its frontier such that $\gamma = \delta 2u/ \delta 2$

Consequently, $0< \gamma <1$ and one may obtain the estimated value of γ

The δ2, and γ, coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumptions made on the distribution form of the error term. The δ2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term. The γ, indicates that the systematic influences that are unexplained by the production function are the dominant sources of random errors.

III. RESULTS AND DISCUSSION

3.1 Stochastic Frontier Production Function and Inefficiency Model Result

From table below the results of farm size revealed that the estimated coefficient was 0.933. This positive effect of farm size on soya bean output implies that a 1 percent increase in the size of farm holding will lead to an increase in output of soya bean by 9.33kg. This could be so because large farm size motivates adoption of innovations which can translate into higher output. The coefficient of farm size was statistically significant at 1 percent level of probability, indicating the relevance of farm size on soya bean production in the study area. This result is in line with the work of Moses (2015), that farm size contributes output.

The coefficient of seed used positively affects output with a value of 0.517. The implication of this positive effect is that if quantity of seed used increases by 5 percent, output will rise by 5.17kg. Production of soya bean cannot be embarked upon if seed is not involved in the production process; hence, quantity of seed used was significant in soya bean production at 5 percent probability level. This result is in agreement with Moses (2015) and Tashikalma (2011).

The estimated coefficient fertilizer was 0.239 of the variable was positive. This agrees with the *a priori* expectation that as the quantity of fertilizer used increases, yield increases as well. However, fertilizer use was not significant because Soya bean does not require much fertilizer. Also, Soya bean improves soil fertility by converting and fixing nitrogen from the atmosphere into the soil.

The estimated coefficient of labour was 0.325. The positive effect implies that 5 percent increase in family labour will leads to increase in output of soya beans with 3.25kg. And it was significant at 5 percent difference from zero since family labour reduces hired labour cost in the production of soya beans in the study area. A similar result by Amaza *et al* (2006) and Moses (2015) equally reported that labour is an important variable in agricultural production.

The coefficient for volume of agrochemicals was negatively signed -0.919 and is not significant for the production of soya bean by the respondents. The implication of the result is that as the volume of agrochemicals used for the production of soya bean increases by a litre, the quantity of soya bean produced decreases. The sign was not as expected because use of agrochemicals reduces drudgery in farm operations such as weeding and clearing as well as increase quantity of output produced stemming from control of pests and diseases.

The estimated gamma parameter (γ) is 0.991 for soya beans and also statistically significant at 1 percent level, indicating that 99 percent of the variation in the total output of production among the sampled farmers is due to differences in their technical efficiencies in the study area. The estimated sigma square (δ^2) for the respondents were (0.308) and significantly different from zero at 1 percent level, this indicates a good fit and the correctness of the specified distributional assumption of the composite error term.

TABLE 1
MAXIMUM LIKELIHOOD ESTIMATES OF THE STOCHASTIC FRONTIER PRODUCTION FUNCTION FOR SOYA BEANS FARMERS

Variable Input	Parameter	Coefficient	standard Error	T- ratio
Constant	(B_0)	0.104	0.106	0.986
Farm size	(B_1)	0.933***	0.759	0.122
Quantity of seed	(B_2)	0.517**	0.322	0.160
Fertilizer	(B_3)	0.239	0.499	0.479
Total Labour	(B_4)	0.325**	0.337	0.963
Volume of Agrochemical	(B_5)	-0.919	0.307	-0.298
Inefficiency model				
Constant	($\delta 0$)	-0.486	0.844	-0.576
Educational level	(δ_1)	-0.763*	0.814	-0.937
Household size	(δ_2)	0.325	0.305	0.106
Age	(δ_3)	-0.117***	0.113	-0.103
Farming experience	(δ_4)	-0.265***	0.261	-0.101
Membership of Cooperative	(δ_5)	0.280***	0.459	0.610
Variances				
Sigma-squared	($\sigma 2$)	0.308	0.293	0.105
Gamma	(γ)	0.991	0.969	0.102

Source: computer printout. 2016
****Estimates are significant at1% level,***
***** Estimates are significant at 5% level.***
*****Estimates are significant at 10% level.***

3.2 Determination of Technical Inefficiency of the Respondents

It should be noted that the negative signs in the inefficiency of the respondents implies positive outcome while the positive sign implies that the outcome is negative vice versa. The negatively estimated coefficient for education is -0.763 for soya bean production this implies that respondents with greater years of schooling tend to be more efficient, because as schooling years increases, technical inefficiency tend to reduce. Technical inefficiency tends to increase output of soya beans by 7.63kg by 10 percent increase. It could be plausible to say that respondents with considerable years of education respond readily to effective decision making in agriculture. This finding is supported by findings obtained by Battese and Coelli (1995) in their study on model for technical inefficiency effect, in stochastic frontier production function for Panel Data. Educational level was statistically significant at 10 percent probability level. Roger and Shoemaker (1971) and Obibuaku (1983) stated that education is not only an important determinant of adoption of innovations but also a tool for successful implementation of innovation.

Household size coefficient had a positive sign in the model which is 0.325. An increase in the number of people in a household will lead to a decline in technical inefficiency of the farmers. Therefore, respondents with larger household sizes tend to have less technically efficient than households with big number of people unless they are all productive.

This is in agreement with the findings of Ekwe and Nwachukwu (2006) who reported that the average household size in Africa was 8-9 persons per household. This is highly indicative of the extended family system in the study area where parents and other relations dwell together as a household. Implication of this finding is that large family size of the farmers probably

necessitated them to learn new agricultural technologies for augmenting production and increasing returns. More family labour would also be readily available since relatively large household size is an obvious advantage in terms of labour supply.

Coefficient of age has negative effect -0.117 on the respondents' technical inefficiency implying that it has positive effect on technical efficiency. This suggests that the older the respondents, the lower the technical inefficiency. As the respondents' age increases by 1 percent the technical inefficiency decreases by 1.17 percent. This is significant from zero at 1 percent. The positive effect of age on technical efficiency indicates that the agility and energetic capability of the respondents contribute to the production of soya beans. This is in agreement with the findings of Shelma (2014), who in his findings reported the positive effect of age on technical efficiency

Farming experience of the respondents had negative and significant coefficient of -0.265, implying that respondents with higher farming experience tend to be more technically efficient in the production of soya bean. A rise in farming experience of the respondents could enhance the skill of the farmers which in turn increase their efficiency. Farming experience was significant at 1 percent level of probability indicating the relevance of accumulation of experience in a farming activity. Maurice (2004) also reported that farming experience increases efficiency in farmers.

Membership of cooperative society was found to have positive effect on technical inefficiency of respondents indicating a rise in technical efficiency as years of cooperative society membership will still not increase their output since they were mostly using their personal savings and vice versa. However, it was statistically significant at 1 percent level as majority of the respondents were not members of any cooperative group. Cooperative society serves as a medium for information exchange that can improve farm output of respondents. This finding contract with the findings of Shelma (2014), who in his findings reported that the longer a respondent stayed in a cooperative society, the lower is his allocative inefficiency.

3.3 Technical Efficiency of soya beans farmers in the study area.

The general distribution of respondents' efficiency presented in Table below shows a minimum of 72 percent and a maximum of 99 percent with a mean efficiency of 90 percent. The obtained mean technical efficiency of the respondents indicates that soya bean farmers in the study area have 10 percent chance for improving production efficiency using the existing technology of the best farmer. Therefore, there is need to increase production by utilizing available resources to attain the frontier level. About 10 percent of the respondents fall between technical efficiency of 70 - 80. Respondents operating at technical efficiency of between 81–90 were 15 percent while respondents with technical efficiency above 91 above were 75 percent. This revealed that there is room for improvement.

TABLE 2
THE TECHNICAL EFFICIENCY DISTRIBUTION OF SOYA BEANS FARMERS.

Variable	Soya beans farming	
Family size	**No. of farmer's**	**Percentages**
70 – 80	8	10
81 – 90	12	15
91 – 100	60	75
Mean	**0.9**	**100**

Source: field survey 2016

IV. CONCLUSION

If the efficiency level of the most efficient farmer is to be attained by all the farmers, cost savings can be achieved with the present level of technology and prices of inputs.

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Long term effect of integrated nutrient management on soil properties and availability of nutrients in a Typic Hapludalfs under maize-wheat cropping

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Abstract**—** *To study the long term effect of integrated nutrient management on soil properties and available nutrients, surface and subsurface soil samples were drawn from the long-term field experiment (LTFE) which is in progress on a Typic Hapludalfs at Research Farm of College of Agriculture, CSK HPKV, Palampur, Himachal Pradesh, India since Rabi, 1972. The rotation followed was maize-wheat and the treatments included various combinations of N, P, K, Zn, lime, hand weeding and farm yard manure. Results from the study showed that integrated nutrient management over the years resulted in improvement in the soil properties as well as status of available nutrients in the soil at both the depths. Continuous application of urea as a source of N has resulted in acidification of soils (pH 4.3) while lime application increased the pH to 6.2 in the surface soil and 6.0 in subsurface soil. The treatment 100 % NPK + FYM resulted in 66 per cent increase in soil organic carbon content over initial value. Similar effects were recorded on cation exchange capacity and available nutrients. It can be concluded from the study that integrated nutrient management is essential to maintain soil health.*

Keywords**— Integrated nutrient management, soil properties, long-term effect.**

I. INTRODUCTION

Fertilizers play vital role in productivity of any crop but continuous and imbalanced use of high analysis chemical fertilizers badly influences soil health and ultimately production potential of soil. With the advent of modern agriculture, farmers are either using restricted amount of organics or no organics. As a result of such nutrient management practices, many of the productive soils are becoming unproductive. This has led to decreasing yield trend even with optimum use of fertilizers particularly under the situations where high yielding varieties are being used. The problem is more severe in acid soils which are under intensive cropping. To secure India's food and nutritional demands, maintenance of soil health is indispensable. Chemical fertilizers alone are unable to maintain the long-term soil health and crop productivity (Subba Rao & Srivastava 1998) as they lack in secondary and micronutrients. Continuous cropping and long-term fertilization are liable to change soil properties and crop productivity. Long-term fertilizer experiments provide the best possible base to monitor changes in soil quality and crop productivity due to continuous manuring and cropping and hence to evolve future strategies for maintaining soil health and enhancing crop yields. With this background, the long term effect of fertilizers and amendments on soil properties and available nutrients was evaluated in the present study.

II. MATERIALS AND METHODS

The long-term fertilizer experiment was laid out during 1972-73 (*Rabi*) under All India Coordinated Research Project on Long-term Fertilizer Experiment to study the effect of various combinations of N,P,K, Zn, lime, hand weeding and farm yard manure on soil quality and maize-wheat productivity . The long- term fertilizer experiment was laid out at the farm of College of Agriculture, Palampur, Himachal Pradesh (32^0N, 76^0E, 1280 m above mean sea level) representing wet temperate zone of Western Himalaya. The soil of the experimental site at the start of the experiment was acidic in reaction (pH 5.8) and silt loam in texture. Taxonomically, the soils are classified as Typic Hapludalfs. The experiment initially comprised of 10 treatments each replicated four times in randomized block design (RBD). The 11^{th} treatment consisting of 100 per cent NPK (-S) was introduced in *kharif*, 1981. Treatments were,T_1-control; T_2-100% N; T_3-100% NP; T_4- 100% NPK; T_5- 100% NPK + FYM @10 t ha^{-1} (to maize crop only); T_6-100% NPK + lime (lime was applied @ 900 kg ha^{-1} till the pH attained at neutrality); T_7-100 % NPK + Zn; T_8-100% NPK + Hand Weeding (HW); T_9-100% NPK (-S), P through DAP; T_{10}-150% NPK (super optimal) and T_{11}- 50% NPK (sub optimal). The N, P and K were applied through urea, single super phosphate and muriate of potash, respectively. In case of 100 per cent NPK (-S), phosphorus was applied through di-ammonium phosphate (DAP). Farm yard manure (FYM) was applied @ 10 t ha^{-1} to maize crop only in a system. Chemical weed control measures were followed except in treatment on hand weeding (100% NPK + HW) in which the weeds were removed manually. Half the dose of N and full dose of P and K were applied at the time of sowing of both the crops. The remaining

half of the N was top dressed in two equal splits at knee high and tasselling stage of maize and maximum tillering and flowering stage of wheat crops, respectively.

After continuous cropping for 37 years, soil samples after harvest of wheat crop (*Rabi* 2008-09) were drawn at 0-0.15 m and 0.15-0.30 m depths to assess soil pH, organic carbon, cation exchange capacity, available nitrogen, available phosphorus and available potassium. Standard methods were used to determine pH, organic carbon, cation exchange capacity, available nitrogen, available phosphorus and available potassium in the soil.

III. RESULTS AND DISCUSSION

3.1 Soil pH

A perusal of data in table 1 showed that continuous cropping and fertilization caused a reduction in soil pH from its initial value of 5.8 recorded in 1972 before the initiation of the experiment. Application of urea as a source of N over the years has resulted in acidification of soils while lime application increased the pH to 6.2 in the surface soil and 6.0 in subsurface soil. The soil pH in the sub-surface soil layer (0.15-0.30 m) varied from 4.3 to 6.0 and the treatment wise trend was almost similar to that in the surface layer.

TABLE 1
EFFECT OF LONG-TERM USE OF CHEMICAL FERTILIZERS AND AMENDMENTS ON SOIL pH

Treatment	Soil depth(m)	
	0-0.15	0.15-0.30
T_1: Control	5.5	5.4
T_2: 100% N	4.3	4.3
T_3: 100% NP	5.1	5.1
T_4: 100% NPK	5.2	5.1
T_5: 100% NPK+ FYM	5.1	5.0
T_6: 100% NPK+ lime	6.2	6.0
T_7: 100% NPK+ Zn	4.9	4.8
T_8: 100% NPK+ HW	5.0	5.3
T_9: 100% NPK (-S)	4.9	4.9
T_{10}: 150% NPK	4.8	4.8
T_{11}: 50% NPK	5.2	5.2
Initial	*5.8*	-
CD (P= 0.05)	0.23	0.23

HW = Hand weeding

Prasad *et al*. (1996) and Sharma *et al.* (2002) reported the moderating effect of FYM and phosphatic fertilizers on pH. This might be attributed to decrease in the activity of exchangeable Al^{3+} ions in the soil solution due to chelation effect of organic molecules (Hue, 1992) and formation of alumino-phosphate complexes, respectively. The marked decline in pH due to the application of 100 % N alone could be ascribed to acidity producing nature of urea as nitrogenous fertilizer (Magdoff *et al.*, 1997) which upon nitrification releases H^+ ions which are potential sources of soil acidity. The application of lime has raised the pH of soil to about 6.2. The ameliorating effect of lime on soil acidity has been reported by many workers (Sharma *et al.* 2002).

3.2 Soil Organic Carbon

Perusal of data in table 2 revealed that except control, the rest of the treatments had shown a slight build up in the content of soil organic carbon over the years. The treatment 100 % NPK + FYM resulted in 66 per cent increase in soil organic carbon content over initial value. The soil organic carbon content in T_8 was 9.2 per cent higher than T_4. The organic carbon content in subsurface layer ranged from 4.8 under control to 9.8 g kg^{-1} under 100 % NPK + FYM treatment. The surface soils contained higher amount of organic carbon in comparison to the subsurface soils. The pattern of effect of different treatments on soil organic carbon content was similar as that recorded in surface layer.

TABLE 2
EFFECT OF LONG-TERM USE OF CHEMICAL FERTILIZERS AND AMENDMENTS ON SOIL ORGANIC CARBON (g kg^{-1})

Treatment	Soil depth(m)	
	0-0.15	0.15-0.30
T_1: Control	8.0	4.8
T_2: 100% N	9.3	6.3
T_3: 100% NP	9.6	6.0
T_4: 100% NPK	10.0	6.7
T_5: 100% NPK+ FYM	13.1	9.8
T_6: 100% NPK+ lime	10.1	6.1
T_7: 100% NPK+ Zn	9.4	5.7
T_8: 100% NPK+ HW	11.0	9.0
T_9: 100% NPK (-S)	9.8	5.9
T_{10}: 150% NPK	10.1	7.2
T_{11}: 50% NPK	9.8	6.8
Initial	*7.9*	-
CD (P= 0.05)	0.29	0.33

The substantial build up in soil organic carbon content in 100 % NPK + FYM treatment was due to the added source of carbon through FYM in T_5 and addition of root biomass and crop residues for thirty six years. The enhanced crop productivity and associated greater returns of organic matter in the form of decaying roots and crop residues in plots receiving balanced dose of either NPK alone or with amendments often gives rise to high organic carbon levels. Slow rate of organic matter decomposition in wet temperate zone could be another reason for buildup of soil organic carbon (Acharya *et al.*, 1988; Sharma *et al.*, 2002).

3.3 Cation Exchange Capacity

A perusal of the data revealed that the CEC in the surface layer ranged from 8.7 c mol (p^+) kg^{-1} under control to 12.3 c mol (p^+) kg^{-1} under 100 % NPK + FYM (Table 3) .

TABLE 3
EFFECT OF LONG-TERM USE OF CHEMICAL FERTILIZERS AND AMENDMENTS ON CATION EXCHANGE CAPACITY {c mol (p^+) kg^{-1}}

Treatment	Soil depth(m)	
	0-0.15	0.15-0.30
T_1: Control	8.7	7.2
T_2: 100% N	6.8	5.8
T_3: 100% NP	9.5	7.8
T_4: 100% NPK	10.6	9.1
T_5: 100% NPK+ FYM	12.3	11.4
T_6: 100% NPK+ lime	11.9	10.9
T_7: 100% NPK+ Zn	9.8	8.2
T_8: 100% NPK+ HW	10.8	9.8
T_9: 100% NPK (-S)	9.3	8.7
T_{10}: 150% NPK	9.4	8.9
T_{11}: 50% NPK	10.3	9.6
Initial	*12.1*	-
CD (P= 0.05)	0.58	0.81

The continuous use of chemical fertilizers and amendments reduced the CEC values in almost all the treatments except that of 100 % NPK + FYM where the initial status of 12.1 c mol (p^+) kg^{-1} was almost maintained. The subsurface layers had lesser values of CEC compared to the surface layer (Table 3). The pH values in different fertilized treatments in present soils varied from 4.3 to 5.2 excluding control and lime treated plots (Table 1). At such low pH values, only the permanent charges of the clays and a small portion of the charges of organic colloids hold ions that can be exchanged by cations (Brady, 1990).

The slight decrease in CEC values of soils in the present study could, therefore, be ascribed to the acidifying effect of chemical fertilizers resulting in reduced pH values in almost all the treatments and prominently in 100 % N treated plots. The comparatively high CEC value in 100 % NPK + FYM treated plots may be attributed to high soil organic carbon content in these plots.

3.4 Available Nitrogen

The data presented in Table 4 revealed that available N content at surface soil layer ranged from 262 kg ha^{-1} under control to 351 kg ha^{-1} under 100 % NPK + FYM treatment. In general, continuous manuring and cropping for thirty six years showed noticeable decline in available N content of soils in all the treatments in comparison to initial value. The initial available N content in soils was 736 kg ha^{-1}, which declined to 262 kg ha^{-1} in the plots receiving zero fertilization after thirty seven years. Application of 100 % N (T_2), 100 % NP (T_3) and 100 % NPK (T_4) resulted in soil N depletion of 64, 57 and 59 per cent, respectively in comparison to its initial content. Highest increase (33.9 %) in available N content over control was recorded with 100 % NPK + FYM followed by 100 % NPK + lime (27.9%). In case of subsurface soil layer, the content of available N declined with increase in depth in all the treatments. However, the effect of various treatments on available N content followed the same trend as was observed in surface layer.

TABLE 4
EFFECT OF LONG-TERM USE OF CHEMICAL FERTILIZERS AND AMENDMENTS ON AVAILABLE NITROGEN (kg ha^{-1})

Treatment	Soil depth(m)	
	0-0.15	0.15-0.30
T_1: Control	262	204
T_2: 100% N	314	288
T_3: 100% NP	304	262
T_4: 100% NPK	320	288
T_5: 100% NPK+ FYM	351	314
T_6: 100% NPK+ lime	335	293
T_7: 100% NPK+ Zn	304	278
T_8: 100% NPK+ HW	330	293
T_9: 100% NPK (-S)	325	278
T_{10}: 150% NPK	325	304
T_{11}: 50% NPK	314	262
Initial	*736*	-
CD (P= 0.05)	34.4	28.4

The leaching losses of N under very high rainfall conditions and its application schedule not synchronizing with the crop requirement might be responsible for such a drastic decline in available N contents. Among different treatments, maximum available N content was recorded under 100 % NPK + FYM treatment after the harvest of wheat crop during 2008-09. The higher content in this treatment may be due to the additional supply of N through FYM over the years. These results are in consonance with those of Sheeba and Chellamuthu (1999) and Sharma *et al.* (2002). The lower contents of available N in untreated plots (T_1) is result of mining with continuous cropping without fertilization over a period of thirty seven years.
The subsurface soils had comparatively lesser values of available N than surface layer which might be due to the less accumulation of organic matter in this layer. The decrease in available N content with increase in soil depth has also been reported by Sheeba and Chellamuthu (1999), Sammy Reddy *et al.* (2003) and Tabassum *et al.* (2010).

3.5 Available Phosphorus

The data reported in table 5 indicated that the available P content declined in the plots where application of P was omitted *i.e.* control and 100 % N treated plots. In general, long-term inclusion of P fertilizers (the treatments involving use of NP and NPK) raised the available soil P above its initial level of 12 kg ha^{-1}. The continuous application of graded doses of P at the rate of 50, 100 and 150 per cent of its recommended level in combination with N and K increased the soil available P content significantly over untreated plots. The available P content in subsurface soils was less, in general, compared to the surface soils. The treatment effects at both the depths, however, were comparable.

TABLE 5
EFFECT OF LONG-TERM USE OF CHEMICAL FERTILIZERS AND AMENDMENTS ON AVAILABLE PHOSPHORUS (kg ha^{-1})

Treatment	Soil depth(m)	
	0-0.15	0.15-0.30
T_1: Control	5.2	3.7
T_2: 100% N	6.8	5.1
T_3: 100% NP	102.0	95.4
T_4: 100% NPK	120.9	113.3
T_5: 100% NPK+ FYM	145.7	120.0
T_6: 100% NPK+ lime	117.6	108.8
T_7: 100% NPK+ Zn	108.1	99.2
T_8: 100% NPK+ HW	77.4	70.0
T_9: 100% NPK (-S)	109.8	102.3
T_{10}: 150% NPK	174.0	151.9
T_{11}: 50% NPK	39.3	30.6
Initial	*12.0*	-
CD (P= 0.05)	9.2	11.1

The substantial build up of available P with its continuous use in these acidic soils is attributed to low crop recovery of applied P and its high stability in the form of residual P (Sharma and Gupta 1997; Zhang *et al*. 1995). The increase in available P might be ascribed to the addition of P at higher rates in T_{10} and inactivation of iron, aluminium and hydroxyl aluminium ions, responsible for P fixation by FYM in T_5 as has been reported by Verma (2002) in the same experimental set up. Besides, decomposition of organic matter releases appreciable quantity of organic compounds which form a cover on sesquioxides and thus reduces the P fixing capacity of the soil (Sharma *et al*. 2001). Lime application also markedly increased the available P status of the soil due to decrease in exchangeable acidity and increase in mineralization of organic phosphates (Kumar and Verma 1997).The low available P content in 100 % N treated plots may be attributed to low pH values of these plots leading to higher P fixation (Sharma *et al.* 2002).

3.6 Available Potassium

There was an increase in available K content under all the treatments over control (Table 6). However, the exchangeable K declined in almost all the treatments in comparison to its status of 194.2 kg ha^{-1} at the beginning of the experiment in 1972 except 100 % NPK + FYM treatment. Combining FYM with 100 % NPK, however, maintained the initial K status of soils. Compared to 100 % NPK, application of FYM along with 100 % NPK and 150 % NPK increased available K content by 18.3 and 10.7 per cent, respectively. The exchangeable K content in the subsurface soils was less in comparison to the surface layers in all the treatments. The treatment wise effect was similar to surface soil layer.

TABLE 6
EFFECT OF LONG-TERM USE OF CHEMICAL FERTILIZERS AND AMENDMENTS ON AVAILABLE POTASSIUM (kg ha^{-1})

Treatment	Soil depth(m)	
	0-0.15	0.15-0.30
T_1: Control	121.2	101.0
T_2: 100% N	134.0	114.5
T_3: 100% NP	128.7	115.2
T_4: 100% NPK	167.6	148.2
T_5: 100% NPK+ FYM	198.3	176.2
T_6: 100% NPK+ lime	175.1	156.5
T_7: 100% NPK+ Zn	169.9	138.1
T_8: 100% NPK+ HW	165.4	146.5
T_9: 100% NPK (-S)	171.4	149.0
T_{10}: 150% NPK	185.6	171.6
T_{11}: 50% NPK	151.2	127.6
Initial	*194.2*	-
CD (P= 0.05)	10.19	5.22

The exclusion of K in crop nutrition (control, 100 % N and 100 % NP) has led to the maximum mining of its native pools over the years. These results are in accordance with the findings of Sharma *et al.* 2002. The high content of available K under 100 % NPK + FYM treatment may be ascribed to additional supply of K through FYM.

IV. CONCLUSIONS

Significant improvement in the soil properties and availability of nutrients was observed by the addition of FYM in combination with chemical fertilizers in surface as well as subsurface layers. Application of lime periodically during 37 years increased the pH of soil from its initial value thereby neutralizing the soil acidity. There is a significant increase in soil organic carbon with the continuous application of FYM to maize crop for 37 years. The integrated use of optimal dose of NPK and FYM is helpful in maintaining soil health. Continuous use of recommended levels of N alone through urea (without FYM) has deleterious effect on soil quality. Imbalanced fertilization has proved to be a great threat to the sustainability of our farming systems. Amelioration of soil acidity in Acid Soil Regions (ASR) besides using recommended application rates of N, P and K is a beneficial proposition under situations where availability of organics (FYM) is limited.

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Hydrogen Bonding - The Key to Desalination (A Review)

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Abstract— *Energy crisis today is a major matter of concern. Energy is the most essential ingredient in the process of economic growth and development. The search for alternative sources for various unit operations such as evaporation, drying, distillation, etc. has been in continuum but without much success. Industries being the major consumers of energy, its efficient usage and minimal wastage are of profound importance.*

ETPs or Effluent Treatment Plants are one of the components of a majority of the industry where a lot of energy is consumed. In every ETP, separate equipments are present to treat salt water. Desalination techniques such as Flash and Multi Effect Distillation in thermal, Electro dialysis and Reverse Osmosis (RO) in membrane category and many other processes such as freezing and humidification are used. For instance RO today is the most commonly used method for desalination. But the problem that accompanies it is that RO rejects concentrated brine solution every time it is used. This massive tonnage of salt water is then sent through a set of Multi-Effect Evaporators which not only increases the cost but majorly increases the energy requirement. The real problem with all the methods used is the need optimum economic designs and higher efficiency requirements thus making it both eco-friendly and economical for the industry. Modifications and innovations such as Incorporation of vacuum in humidification system increases the evaporation rate of water due to reduction in boiling point. In Electrodialysis, ion exchange resins are incorporated between the electrodes which help separate out ions into continuous streams. These provide continuity to the process and also enhance its rate. But still the need for energy turns out to be the major issue. This paper suggests an alternative innovative technique reduction in h bonding of water that can virtually eliminate the excessive energy needs in these processes.

Keywords— Desalination, RO, Electrodialysis, Humidification, Solvents.

I. INTRODUCTION

Desalination of water is a major concern for both industries as well as for municipal supply across the globe. The demand for freshwater is ever increasing .ie demand for freshwater in the MENA(Middle East and North Africa Region) is estimated to go from 42 today to 200km^3 in year 2050[1].Also industries that include Oil & Gas, Refining & Petrochemicals, Power Generation Food and Beverage, Pharmaceutical, Microelectronics, Pulp & Paper, and Mining industries also make use of various desalination technologies to obtain freshwater for different purposes[2].The crisis doesn't only include the costs of maintenance and running of desalination units but also the environmental impact that these methods are causing. For example Saudi Arabia alone is burning 1.5 million barrels of crude oil per day equivalent to produce freshwater through desalination releasing massive amounts of greenhouse gases into the atmosphere [1].

This paper is an attempt to describe the currently used methods and the problems associated with them both in operation as well as maintenance. Also an alternative innovative technologies that can be adapted instead of or in combination with the current technologies.

II. EXISTING METHODS:

Commercial technologies for desalination include membrane separation processes such as reverse osmosis (RO) and electro dialysis (ED), multi effect distillation (MED), multistage flash (MSF) and vapour compression distillation (VCD). These technologies are the most widely used desalination processes with MSF and RO with a total share of about 78% [3].Also the use of direct solar energy for desalinating seawater is being investigated quite extensively.

The issues faced in the most common methods are listed as follows are listed as follows:

2.1 Membrane technology

This mainly includes RO and ED. In RO high pressures up to 70-90 bars is required and for every single unit of freshwater produced around 1.5 times of that amount is recovered as reject[1].The common problem of fouling and scaling is also a major issue but can be controlled by pre-treatment can reduce these to a certain extent. Fouling of membranes is a major issue in spite of advances in membrane technology. Problems of concentration polarisation also persist. Adaptability i.e.: variation in feed concentration also causes trouble in setting of membrane based processes.

2.2 Thermal Technologies

These are the most commonly used especially in regions with high availability of energy sources. These include MSF, MED, VCD, etc. These are the most commonly used especially in regions with high availability of energy sources. These include MSF, MED, VCD, etc.

The main issues with these are fouling, high energy requirements, larger footprint requirement, corrosion problems and most of all environmental pollution due to extensive use of fossil fuels as energy resources. Use of vacuum for higher efficiency is also used but is a costly affair.

2.3 Renewable Energy Powered Conventional Desalination

Most promising energy source that is being investigated to replace various sources of energy is solar. These can be broadly classified into 2 categories concentrating solar power (CSP) technology and photovoltaic (PV) technology.

PV is conversion of solar radiations to electricity which in turn is used in various desalination processes. But the lower efficiency of PV panels, high setup costs and large area requirements limits its application in this particular field.

CSP technology is the most promising methodology to extract solar energy that would take the mantle as the most viable and eco-friendly alternative to current sources of energy in desalination. Various models have been proposed that include use of parabolic trough collectors, Fresnel lenses, solar towers, etc. but the current available technology is insufficient in meeting the world's requirements [7]

Also other sources of renewable energy such as wind, geothermal etc. have also been proposed but none of these sources with today's technology are potent enough to satisfy current energy needs. Thus more of R&D and vigorous improvement in efficiencies might make these sources a viable solution in the future but as of now the issue of energy crisis persists.

III. SUGGESTED SOLUTION

The current area of research focuses on either optimising the current methods or finding greener and cheaper alternatives to meet the current and future's humongous energy needs. In this paper we propose an alternative means of desalination that minimises, rather virtually eliminates the need for high energy sources. The method is as follows:

3.1 Reduction of H-bonding

Hydrogen bonding forms in liquid water as the hydrogen atoms of one water molecule are attracted towards the oxygen atom of a neighboring water molecule; generally, a proton shared by two lone electron pairs. In a water molecule (H2O), the oxygen nucleus with +8 charges attracts electrons better than the hydrogen nucleus with its +1 charge. Hence, the oxygen atom is partially negatively charged and the hydrogen atom is partially positively charged. The hydrogen atoms are not only covalently attached to their oxygen atoms but also attracted towards other nearby oxygen atoms. This attraction is the basis of the 'hydrogen' bonds. Hydrogen bonds arise in water where each partially positively charged hydrogen atom is covalently attached to a partially negatively charged oxygen from a water molecule with bond energy of about 492 KJ/mol and is also attracted, but much more weakly, to a neighboring partially negatively charged oxygen atom from another water molecule. This is the very reason that water remains a liquid at Room Temperature (R.T) whereas its counterparts such as H_2S, etc. are gases. The hydrogen bonding in water, together with its tendency to form open tetrahedral networks at low temperatures, gives rise to its characteristic properties, which differ from those of other liquids. Such properties of other liquids are often described as 'anamalous' although it could well be argued that water possesses properties that one might deduce from its structure. Quite small percentage changes in the strength of the aqueous hydrogen bond may give rise to large percentage changes in such physical properties as melting point, boiling point, density and viscosity. There is considerable hydrogen bonding in liquid water resulting in high cohesion which prevents water molecules from being easily released from the water

surface. Consequentially, the vapor pressure is reduced and water has a high boiling point. The percentage reductions in the hydrogen bond strength that result in lower boiling points is given in graph below

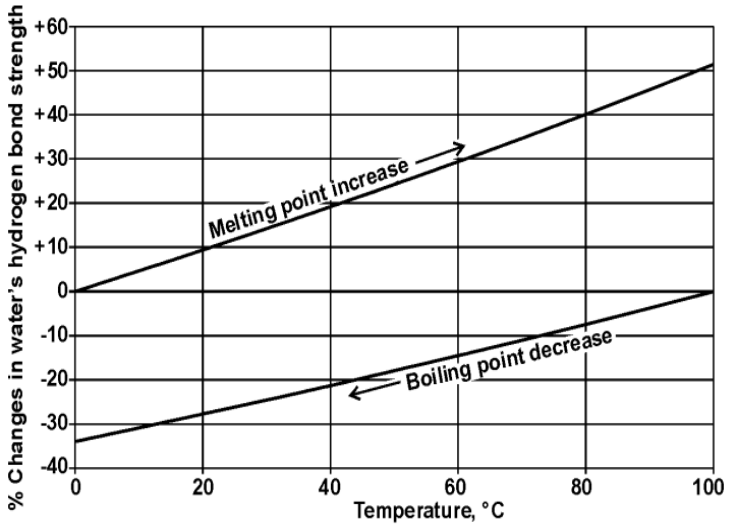

FIGURE 1: CHANGE IN BOILING POINT OF WATER WITH % REDUCTION IN H BONDING

If the strength of this H-bonding is reduced even by a minor percentage then desalination can be performed at a temperature slightly over R.T.(37^{o}C)[5**].**Thus at a temperature little over R.T water can be completely separated from salts. The main advantage of using such a process would be that many sources are available for provision of energy to heat feed water to 37 ^{o} C thus reducing the costs incurred due to energy requirements to a bare minimum. Currently, uses of chaotropic agents such as Guanidium chloride, Sodium dodecyl sulfate, urea etc. are being investigated for this purpose.

TABLE 1
ESTIMATES OF EFFECTS CONSEQUENT ON VARYING WATER'S HYDROGEN BOND STRENGTH

%Change in hydrogen Bond	Effect at 37^{o}C
Decrease 29%	Water boils
Decrease 18%	Most proteins heat denature
Decrease 11%	K + becomes kosmotropic
Decrease 7%	pKw up 3..and so on

IV. CONCLUSION

Desalination today is a major matter of concern, both for municipal supplies as well as the industry, especially in regions such as MENA where freshwater reserves are scarce. The demand for freshwater is predicted to increase exponentially in the coming decade thus also raising demands for alternative energy resources. Developing countries, currently having abundant water resources, are going to face scarcity in the near future due to over exploitation of this valuable natural resource. Also those which do not have access (geographical and economical) to sufficient energy resources are going to suffer if this trend continues [7].

Although current techniques used for desalination are being continuously optimized and economized, the tremendous energy requirements remain a major issue that needs to be catered. Novel technological innovations in ED by various technology providers are slowly giving it better acceptance over RO or other membrane technologies. Use of renewable sources to meet these requirements is a viable option but as of today none of those sources are extracted efficiently enough to meet the ever growing demands of this industry. In experiments conducted by us on a lab scale, the suggested chaotrops and kosmotrops have given us a mere drop of $5\text{-}10^{0}$C.Hence this is currently not a full proof method for scaling up. The alternative suggested in this paper, if implemented on a large scale, can virtually eliminate the concern in relation with energy requirements. Further developments and finally implementation of this novel technique can be done in the near future thus solving the energy crisis that persists, at least in the field of desalination.

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The effect of organic mulch on the growth and yield of Spinach (*Spinacia oleracea L*)

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***Abstract*—** *An experiment was conducted in a greenhouse at the Luyengo campus of the University of Swaziland to determine the effect of organic mulch on the growth and yield of spinach. The experiment was conducted between the months of January and February, 2017. The experiment was a completely randomized design (CRD), with treated sewage mulch (TSM) and organic compost mulch (OCM) as treatments. The no mulch (NML) was used as a control. Spinach seedlings were planted at a spacing of 15 cm within rows and 30 cm between rows. Weeding and pest control measures were done uniformly across the treatments, when and as required. The data collected included the percentage moisture retained by the different treatments on the soil, growth parameters (leaf width, leaf length, leaf number, leaf area, plant height) and yield at harvest. The results displayed a significant difference ($P<0.05$) between the treatments in terms of the moisture retention properties. Organic compost mulch recorded the highest mean percentage moisture retention (22.9%), followed by treated sewage mulch (20.9%) and no mulch recorded the lowest percentage moisture retention in the soil (14.4%). All the growth parameters were higher for spinach growth under TSM, followed by that grown under OCM. They were lowest under spinach grown under no mulch. The differences in mean for parameters were significant ($p<0.05$). The yield also varied across the treatments as TSM had a dry mass of 43.0 g, followed by OCM at 23.4 g and the no mulch treatment recorded a dry mass of 20.9 g. The results showed that mulching improved the performance of the spinach plants in terms of plant growth, moisture retention and yield.*

***Keywords*—Compost, mulch, organic, sewage, spinach.**

I. INTRODUCTION

Spinach is one of the significant vegetables grown in the Kingdom of Swaziland. This green leafy vegetable is principally believed to have come from south-western Asia [1]. Production of spinach in the country is dominant on communal land where subsistence farming is practiced [2]. Subsistence agriculture is characterized by small scale production on a few square metres of land, mainly for the purpose of providing food for the families [3]. Spinach production is also important due to its health benefits as it supplies the body with nutrients such as Vitamin A, C and K. Vegetables such as spinach are also beneficial because they form a significant constituent of the Swazi nation's diet, because it can be served in a variety of dishes [4]. Low soil fertility intensity is one of the major contributors to the little productivity of vegetable crops in Swaziland. The fertility of the soil can be improved by the application of organic as well as inorganic fertilisers. The use of inorganic fertilisers proves to be very expensive and may also cause other side effects in the soil such as soil salinity [5].The use of organic methods such as composting, to restore soil fertility and soil physical properties has gained attention in the agricultural sector [6].

Compost has a similar composition to the soil organic matter thus it also enhances the physical properties of the soil such as the soil structure as well as the soils moisture and nutrient retention abilities [7]. Compost also helps maintain the nutrients in the soil for elongated periods of time since it is composed of differently sized constituents, which break down in the soil at varying decomposition rates, making the nutrients to be constantly available [8].Treated sewage sludge can also be used as a compost [9]. Sewage sludge contains vital plant nutrients as well as organic matter which may be utilized in crop production such as spinach, to substitute as well as increment the use of synthetic fertiliser in the country [10]. It enhances the physical, chemical and biological properties of the soil [11]. Plant nutrients contained in sewage sludge play an important role in the improvement of plant biomass [12]. The objective of the study was to determine the effect of compost on the growth and yield of spinach.

II. MATERIAL AND METHOD

The experiment was carried out in a greenhouse at the University of Swaziland, Luyengo campus, which is located in the semi-arid region of the country. The greenhouse was located at 26.67543 ^{o}S latitude, 31.17867 ^{o}E longitude at altitude of 735 m above sea level. This area is characterized by moderate temperatures and average annual rainfall.

The research was an experiment with Completely Randomized Design (CRD). The treatments for the experiment were organic compost mulch (OCM), treated sewage sludge mulch (TSM) and no mulch (NML) which was the control treatment. The organic compost mulch was acquired from a commercial supplier, while the treated sewage sludge was obtained from the sewage treatment plant for Manzini city located at longitude 31.23 ^{o}E and latitude 26.3567 ^{o}S. Each treatment was replicated three times. The OCM and TSM treatments were applied at 400 grams per planting basin, at the time of transplanting. The experiment was conducted in well prepared plots and each plot had four spinach plants. The experiment had a total of 36 plants.

The planting plots were prepared to a fine tilth in the greenhouse using a fork and rake. The seedlings were obtained from a commercial supplier and they were planted at a spacing of 15 cm within rows and 30 cm between the rows. Weeding and pest control practices were carried out when and as required, according to weed growth or appearance of pests. The plants were watered after every two days using a watering can and each plant received 1litre of water based on the crop water consumptive use and the field capacity of the soil which was estimated using the oven drying method.

The data collected were moisture retention, leaf width, leaf length, leaf number, plant height, wet mass and dry mass. Three spinach plants were randomly selected from each plot for data collection. Growth parameters were measured on a weekly basis. The leaf width was measured by placing a ruler across the leaf in the middle part of the leaf. The plant leaf height was measured by using a measuring tape from the ground to the topmost part of the plant. The number of leaves was obtained by counting the individual leaves and the average number of leaves per treatment was used for data analysis. The leaf area was computed using equation 1.

$$LA = (L \times W \times 0.7) \quad (1)$$

Where;

LA – Leaf Area (cm^2)

L – Length of Leaf (cm)

W – Width of Leaf (cm)

0.7 – Correction factor

The soil moisture retention properties of the different treatments were determined using the oven drying method whereby soil samples from each of the three treatments were weighed on a balance scale and oven dried for 24 hours at 105 °C. This was done on a weekly basis, prior to irrigation.

The dried soil samples were weighed again and the moisture content computed using equation 2.

$$\% \text{ Moisture Content} = \frac{Ww - Wd}{Wd} \times 100 \quad (2)$$

Where;

Wd – Dry weight of sample

Ww – Wet weight of sample

Fresh and dry mass of the plants was determined some seven weeks after planting. The plants were detached from the soil and splashed off of any moveable soil materials and other inert matter. The spinach plants were then lightly wiped off with soft paper towel to get rid of free water on the surfaces of the leaves. The fresh mass was then determined by weighing the spinach. The harvested plants were then oven dried at 75° C for a period of 72 hours and then weighed to determine the dry mass.

The data collected during the course of the experiment were analysed using the Statistical Package for Social Sciences [13], whereby analysis of variance (ANOVA), was done in order to determine any significant differences between the treatments. The mean separation test was also carried out using the Least Significant Difference (LSD).

III. RESULTS AND DISCUSSIONS

The organic compost mulch treatment recorded the highest mean soil moisture content (22.9 %) which meant it was a better mulching material when compared to treated sewage mulch (Fig 1). The control treatment had the lowest mean moisture content (14.4 %). This was due to the fact that there was higher rate of evaporation in the no mulch treatment because the soil was exposed to evaporation agents such as solar radiation and wind currents. The differences in mean soil moisture content were significant ($p<0.05$).

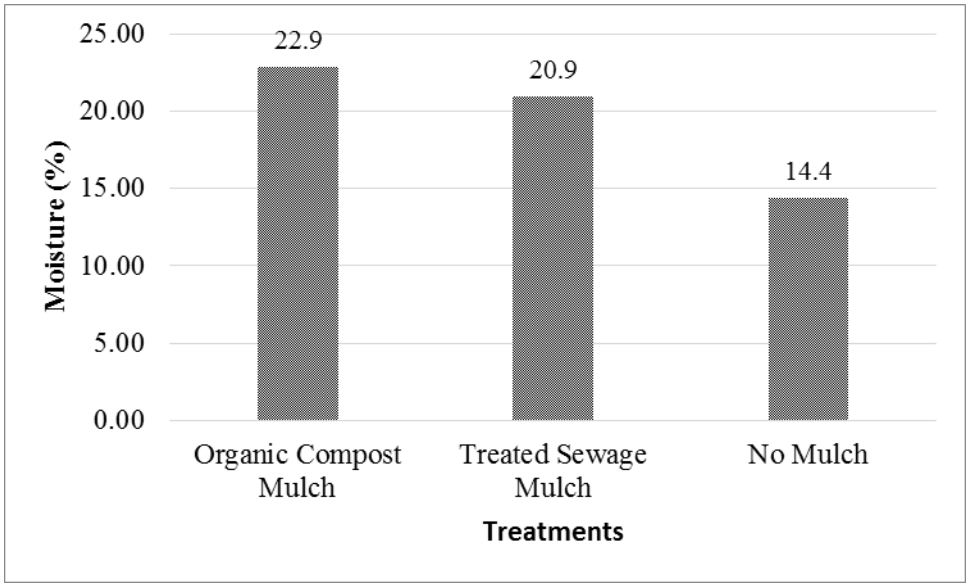

FIGURE 1: MEAN MOISTURE CONTENT BETWEEN TREATMENTS

The spinach under treated sewage mulch had the highest mean leaf width (16.0 cm) as compared to that grown under organic compost mulch, which had mean leaf width of 11.9 cm. On the other hand, the control treatment had mean leaf width of 9.5 cm (Table 1). The differences in mean leaf width between OCM and TSM were significant, as well as those between TSM and NML ($p<0.05$). The maximum leaf length was obtained in the spinach grown under TSM with mean leaf length of 20.4 cm. It was followed by that grown under OCM at mean leaf length of 14.6 cm. The plants grown under NML had the least mean leaf length at 12.0 cm (Table 1). The analysis showed that the differences in mean leaf length were significant ($p<0.05$).

TABLE 1
MEAN VALUES FOR PARAMETERS UNDER DIFFERENT TREATMENTS

Treatment	Parameters*						
	Leaf width (cm)	Leaf length (cm)	Leaf area (cm^2)	Leaf number	Plant height (cm)	Wet mass (g)	Dry mass (g)
Organic compost mulch	11.9^{a}	14.6^{a}	138.3^{a}	6^{a}	17.5^{a}	344.0^{a}	23.4^{a}
Treated sewage mulch	16.0^{ab}	20.4^{ab}	250.5^{ab}	8^{ab}	23.7^{ab}	651.5^{ab}	43.0^{ab}
No mulch (control)	9.5^{b}	12.0^{b}	55.4^{b}	5^{b}	13.7^{b}	317.8^{b}	20.9^{b}

Parameters on same column with same symbol indicate that their means were significant different.

The results showed the highest leaf area in the spinach plants grown under treated sewage mulch, as they had an average leaf area of 250.5 cm^2. It was followed by the spinach plants grown in the organic compost mulch with area of 138.3 cm^2. The lowest mean leaf area was recorded from the spinach planted with no mulch at 55.4 cm^2 (Table 1). The mean leaf area values were significant between OCM and TSM, as well as between TSM and NML ($p<0.05$). Spinach plants grown under TSM had the highest mean plant height at 23.7 cm. It was followed by plants from OCM at 17.5 cm, and the lowest was plants from NML at 13.7 cm.

Both dry mass and wet mass was higher for plants grown under TSM at 651 g and 43.0 g respectively. This was followed by plants grown under OCM, with wet mass and dry mass at 344.0 g and 23.4 g respectively. The wet mass and dry mass was the lowest for plants grown under no mulch at 317 g and 20.9 g respectively (Table 1). The means for wet mass and dry mass were significant different for OCM and TSM, as well as for TSM and NML ($p<0.05$).

IV. CONCLUSION

The results showed that the growth rate and yield of spinach plants grown on the treated sewage mulch and the organic compost mulch were better when compared to that of spinach plants grown without mulch. Treated sewage mulch produced spinach plants with the highest growth rate as the plants exhibited a higher mean leaf area, leaf width, leaf length leaf number and plant height. The dry yield across the treatments was 43.0 g in the treated sewage mulch, 23.4 g in the organic compost mulch and 20.9 g in the no mulch treatment. The treated sewage waste resulted in higher yield of spinach compared to all the other treatments. It is concluded that the mulch had a positive effect on the yield of spinach.

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Comparative Analysis of the proximate Composition of palmyrah pinattu and flours (Odiyal, Boiledodiyal)

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Abstract— *Palmyrah (Borassusflabellifer) fruit is mostly used as fresh fruit, because of its perishable nature it is traditionally preserved as dried fruit pulp called as pinattu (fruit leather). It contained pectin as well as contain appreciable amount of saponinbecause of that fruit pulp having important medicinal properties. Considering these facts the phytochemical constituents of solvent extracts of pinattuwas identified and evaluated. Samples was collected from the three different branches ofPalmyrah Development Board.*

Pinattu, boiled odiyal flour and odiyal flour contained 16.6±(0.008), 11.66±(0.001), 10.66±0.001 g/100g of moisture, 2.23±0.062, 6.51±0.062, 6.7813±0.06 g/100g of protein, 0.08±0.001, 0.28±0.008, 0.43±0.013 g/100g of Fat, 0.04±0.001, 0.02±0.0003, 0.02±0.0002 g/100g of Ash, 5.06±0.01, 7.13±0.18, 4.49±0.15 g/100g of crude fiber and (75.91±0.61, 74.37±0.65, 77.59±0.5 g/100g of carbohydrate respectively. There were significant different ($p<0.05$) between the each samples for all the nutrient content except moisture content.

Keywords— Pinattu, Odiyalflour, Boiled odiyal flour, Nutritional.

I. INTRODUCTION

*Borassusflabellifer*L. , belongs to family Arecaceae,(Asmussenet al., 2006) commonly known as Palmyra palm or Asian toddy palm is a native of tropical Africa (Nesbitt, 2005). The coconut like fruits are three sided when young, becoming rounded or more or less oval, 12-15 cm wide, and capped at the base with overlapping sepals (Morton, 1988).This plant has a commercial and medicinal value (Ghosh et al., 2012). The fruit pulp of *B. flabellifer*has been used in traditional dishes The different parts of the plant is used for the various ailments like secondary syphilis, antiperiodic, heart burns, liver and spleen enlargement etc. It has anti-inflammatory effects (Nadkarni, 1954; Vaidyaratnam, 1994; Kapoor, 2000).

The availability of good data provides a strong foundation for the more important next step - the analysis of the information. So Proximate Nutritional Composition Determination of pinattu, Boiledodiyal flour and odiyal flour also in the analysis of information and facilitate a better understanding of palmyrah products. Measurement of nutritional status is one of the key indicators for monitoring the overall welfare of a population and measuring the impact of change in factors that affect the welfare of a population. Negative change in the nutritional status of a population indicates a problem. (Food Security Analysis Unit for Somalia (FSAU). 2005) and nutrition is the science of food in relation to health. Nowadays the focus on nutrition is based on a new definition of health as "prevention of disease" in which nutrition plays a key role yet most people are unsure whether certain foods are good or bad for them so the Nutritional analysis was most important for the population. **Dried raw tuber flour (odiyal Flour)** Raw tubers are split into two halves. Usually they are stored in the form of dried pieces and milled only when needed for make odiyal flour. **Boiled odiyal flour** Boiled tubers are split into two halves and sun dried then milled into flour is known as Boiled odiyal flour ('Pullukodiyal flour').

II. MATERIAL AND METHOD

2.1 Sampling

Palmyrah samples were obtained from the three different branches of PDB (Palmyrah Development Board) then pool together. After that 100g of sample was weighted in random manner**.**

2.2 Proximate analysis

The proximate compositions of the pinattu, boiledodiyal flour, odiyal flour were determined using standard analytical methods. All measurements were done in duplicates and values presented in percentage.

2.3 Determination of Ash content (AOAC 2000)

Sample preparation

Sample was prepared and 5g of sample was weighed in porcelain crucible. It was kept in muffle furnace at 550^{o}C for 5 hours. Then it was transferred in to desiccator for the cooling. The sample was weighed after cooling.

2.4 Determination of Moisture Content (AOAC 2004)

Dried petri dishes were taken and weighed (M_0) by using the analytical balance. Then 5g of sample from each were weighed in petri dishes (M_1). Samples with Petri dishes were placed in the hot air oven at 105^{0} c for 3hours. After that dishes were taken and were transferred in to the desiccator and weighed (M_2). This procedure was repeated until get the constant weight. Then moisture contend was determined.

2.5 Determination of Protein Content (AOAC 2000)

1g of samples from each were taken and transferred in to kjeldhal digestion flask carefully. 1g of catalyst mixture and 10ml of con.$H_2SO_4$was added in to each kjeldhal flask. Then flasks were placed kjeldhal digester at 250^{o}C for 90 minutes and then 410^{o}C for 90 minutes. After completion of digestion flask were allowed to cool to room temperature. 50 ml of distilled water was added in to each digestion flask. Contents were distilled with addition of 40% of NaOH. Distillate was collected in conical flask containing 4% of 15 ml boric acid with mixed indicator. Contents in conical flask were titrated against 0.05N HCl until colour changes from pink to blue.

Protein percentage = Percentage of Nitrogen × 6.25

2.6 Fat content determination

Fat was determined using soxhlet fat extraction method [AOAC 1995].

Sample (5.0g) with filter paper was transferred into pre-weighed thimble and pre-weighed syntax crucible and thimble was attached to the extractor. Fat was extracted with petroleum ether (Boling point 40-60°C, 70mL) in solvent extractor.

Programmed was set as Heating plate temperature (110°C), Immersion (60min), Washing (60 min), Recovery(5 min). The concentrated extract with few milliliters of petroleum ether was transferred into clean dried weighed crucible and placed in an oven at 100°C for about 30 minutes and it was cooled and weighed. Residual was kept for crude fiber determination.

2.7 Estimation of Crude fiber

Crude fiber was determined by Weende method as described in U.S AOAC (1995)

Method

Fat free sample (1g) was in a pre-weighed Crucible.1.25% (w/v) of H_2SO_4 was adds up to the 150 ml notch after pre heating by the hotplate in order to reduce the time required for boiling.5 drops of n-octanol was added as antifoaming agent, it was boiled for 30 minutes exactly from the onset of boiling, after that connected to vacuum for draining H_2SO_4 and washed three times with 30 mL (crucible filled up to top) of hot demonized water, connecting each time to compressed air for stirring the content of crucible. After draining the last wash 150mL of preheated KOH (1.25%w/v)) was added and 5 drops of antifoam also. Then it was boiled 30 minutes, filtered and washed, last washing with cold deionized water to cool, the crucible and then crucible content was washed three times with 25 ml of acetone, stirring each time by compressed air. Finally the crucible was removed and the dry weight was determined after drying in an oven at 105^{0}C for an hour or up to constant weight then cooled in desiccators. This weight represents the crude fiber + ash content in comparison to initial weight. The crucible with insoluble matter was placed in a muffle at 550^{0}C for three hours and reweighed after cooling in desiccators. The crude fiber contents in 100g sample were calculated. Three replicates were done.

Calculation

W_1g = Weight of crucible, Fiber and ash

W_2g = Weight of crucible and ash

W_3g = Weight of fresh sample

Fiber % = $(W_1-W_2)/ W_3$x100

2.8 Carbohydrate determination

The carbohydrate content of the test sample was determined by estimation using the arithmetic difference method [D.A. Pearson 1976].

$$\%CHO = 100 - (\%\ fat. + \%\ ash + \%\ fiber + \%\ protein)$$

2.9 Statistical analysis

The results obtained from products with three replicate were subjected to analysis of variance by complete randomized design (CRD). The significant difference among the extracts was tested in Least Significant Difference (LSD) at 5 % level of significance using SAS software.

III. RESULTS AND DISSECTION

Measurement of nutritional status is one of the key indicators for monitoring the overall health of inhabitants and measuring the impact of change in factors that affect the safety of population. Pinattu, boiled odiyal flour and odiyal flour were showed significant different ($p<0.05$) for all nutritional parameters except moisture content. Pinattu showed highest moisture content than flours while there were no significant different between odiyal and boiled odiyal flours. Odiyal flour has highest protein, fat and carbohydrate content when compared with boiled odiyal flour because during the processing of boiled odiyal flour water soluble compound was washed out. Whereas ash and crude fiber content of boiled odiyal flour was significantly higher than odiyal flour. Crude fiber content of pinattu, boiled odiyal flour and odiyal flour were 5.0612(±0.01), 7.1338(±0.18) and 4.4965(±0.15) respectively.

TABLE 1
PROXIMATE COMPOSITION OF PINATTU, BOILEDODIYAL FLOUR AND ODIYAL FLOUR (g/100g)

sample	Pinattu	Boiled odiyal flour	Odiyal flour
Moisture	16.6667(±0.008)^{a}	11.6667(±0.001)^{b}	10.6667(±0.001)^{b}
Protein	2.23127(±0.062)^{c}	6.5188(±0.062)^{b}	6.7813(±0.062)^{a}
Fat	0.0810(±0.001)^{c}	0.2840(±0.008)^{b}	0.4349(±0.013)^{a}
Ash	0.0428(±0.001)^{a}	0.0213(±0.0003)^{c}	0.0203(±0.0002)^{b}
Crude Fiber	5.0612(±0.01)^{b}	7.1338(±0.18)^{a}	4.4965(±0.15)^{c}
Carbohydrate	75.9171(±0.61)^{b}	74.3765(±0.65)^{c}	77.5994(±0.52)^{a}

Each value in the table is represented as mean ± SD (n = 3). Values in the same rows followed by a different letter (a-c) are significantly different (p< 0.05).

Sahniet al., 2014 stated that the nutritional analysis of the palmyrah dried roots has shown 8.54% protein content, 23.53% carbohydrates, 7.29% crude fiber and negligible fat content.

IV. CONCLUSION

Findings from this research work have revealed great potential food uses of palmyrah based products. These products have appropriate amount of protein content as well as those were very good source of fiber therefore which could be used in various food applications.

RECOMMENDATIONS

It is hereby recommended, based on the findings of this research work that increased efforts would be made to encourage the utilization of palmyrah based food products and further studies need to evaluate the antioxidant activity of these palmyrah based products.

Conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired.

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