ABOUT JABSD

The Journal of Agricultural Biotechnology and Sustainable Development (JABSD) (ISSN: 2141-2340) is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as Effects of nitrogen fertilizer and irrigation regimes on seed yield of calendula, Partial purification of leaf lectin from Manihot esculenta and screening its fungicidal activity, genetic variability and interrelationship among the different traits in Microsperma lentil, Histopathology of Raphia hookeri leaf infected with Glomerella cingulata causing seedling blight, Effect of explant type, source and genotype on in vitro shoot regeneration in Macadamia etc.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JABSD are peer-reviewed.

Journal of Agricultural Biotechnology and Sustainable Development (JABSD) (ISSN: 2006-9774) is published monthly (one volume per year) by Academic Journals.

Submission of Manuscript

Submit manuscripts as an e-mail attachment to the editorial office at: jabsd@academicjournals.org. A manuscript number will be mailed to the corresponding author shortly after submission.

The Journal of Agricultural Biotechnology and Sustainable Development will only accept manuscripts submitted as e-mail attachments.

Please read the Instructions for Authors before submitting your manuscript. The manuscript files should be given the last name of the first author.
Editors

Prof. Olaleye A.O
Department of Soil Science & Resource Conservation,
Faculty of Agriculture,
The National University of Lesotho, Roma 180,
Lesotho.

Prof. Ji-Hong Liu
College of Horticulture and Forestry Sciences,
National Key Laboratory of Crop Genetic Improvement,
Huazhong Agricultural University, Wuhan, 430070,
China.

Dr. Olufemi Martins Adesope
University of Port Harcourt, Nigeria,
Nigeria.

Dr. Anil Vyas
Microbial Biotechnology and Biofertilizer Laboratory,
Department of Botany, J.N. Vyas University,
Jodhpur, India.

Prof. Mohamed Fouad M. Abdalla
Head of Vegetable Sci. Division,
Faculty of Agric., Assiut University, Assiut, 71526,
Egypt.

Dr. Guy L. Plourde
Departement of Chemistry,
The University of Northern BC,
3333 University Way, Prince George,
BC, Canada,
V2N 4Z9.

Prof. Shao Hongbo
Institute of Life Sciences,
Qingdao University of Science & Technology,
China.
Editorial Board

Dr. Kamal Ghasemi Bezdi  
**Cotton Research Institute of Iran**,  
Behesht St, Gorgan, Iran.

Dr. Hossein Aliabadi Farahani  
**Islamic Azad University of Shahriar (Shahr-e-Qods)**  
Branch, Iran.

Dr. Henry de-Graft Acquah  
**Department of Agricultural Economics and Extension**,  
School of Agriculture, University of Cape Coast,  
Cape Coast, Ghana.

Dr. Shi Lei  
**College of Life Science, Qufu Normal University**,  
Shandong Province, P.R. of China.

Dr. Johnson Toyin Fasinmirin  
**Federal University of Technology, Akure**,  
Nigeria.

Dr. Olufemi Martins Adesope  
**University of Port Harcourt**,  
Nigeria.

Dr. Selene Aguilera  
**Centro De Investigacion Y De estudios Avanzados Del**,  
I.P.N Unidad Irapuato (Cinvestav-Unidad Irapuato),  
Mexico.

Dr. Shaid Javed Butt  
**MAS-Arid Agriculture University, Rawalpindi**,  
Pakistan.

Dr. Birinchi Kumar Sarma  
**Institute of Agricultural Sciences**,  
Banaras Hindu University, Varanasi 221005, India.

Dr. R. Khalid Hussain  
**Shakargarj Sugar Research Institute**,  
Jhang, Pakistan.

Dr. Syed Zia ul Hussain  
**Plant Bacteriology and Plant Pathologist**,  
Shakagarj Sugar Research Institute, Toba Road Jhang,  
Pakistan.

Dr. Taiga Akpovughaye  
kogi state university, Anyigba, Department of  
Biological Sciences, Nigeria.

Dr. Hamdi Abbas Ibrahim  
**Nobles Group**, Sudan.

Dr. Vo Quang Minh  
**Cantho University**, 3/2 Street, Ninh kieu district,  
Cantho City, Vietnam.

Prof. Alex C. Chindah  
**Institute of Pollution Studies Rivers State, University of**  
**Science and Technology**, Nkpolu-Oroworukwo,  
PortHarcourt, Nigeria.

Dr. Ömür Baysal  
**West Mediterranean Agricultural Research Institute (BATEM)**,  
Turquy.

Dr. Aditya Garg Pratap  
**West Mediterranean Agricultural Research Institute (BATEM)**,  
Turquy.

Dr. J. Francis Borgio  
**Department of Microbiology, St. Joseph’s College (Autonomous)**,  
Bangalore – 27, India.

Dr. Radhakrishnan Senthil Kumar  
**Center for Research and PG studies, Indian Acdaemy Degree college**,  
Bangalore, India 560043,

Dr. Ali Abdullah Alderfasi  
**King Saud University, College of Food and Agricultural Science**,  
Riyadh, Saudi Arabia.

Prof. Mousumi Debnath  
**Jaipur Engineering College and Research Centre, (Affiliated to Rajasthan Technical University and accredited by All India Council of technical education)**,  
India.
Instructions for Author

Electronic submission of manuscripts is strongly encouraged, provided that the text, tables, and figures are included in a single Microsoft Word file (preferably in Arial font).

The cover letter should include the corresponding author’s full address and telephone/fax numbers and should be in an e-mail message sent to the Editor, with the file, whose name should begin with the first author’s surname, as an attachment.

Article Types
Three types of manuscripts may be submitted:

Regular articles: These should describe new and carefully confirmed findings, and experimental procedures should be given in sufficient detail for others to verify the work. The length of a full paper should be the minimum required to describe and interpret the work clearly.

Short Communications: A Short Communication is suitable for recording the results of complete small investigations or giving details of new models or hypotheses, innovative methods, techniques or apparatus. The style of main sections need not conform to that of full-length papers. Short communications are 2 to 4 printed pages (about 6 to 12 manuscript pages) in length.

Reviews: Submissions of reviews and perspectives covering topics of current interest are welcome and encouraged. Reviews should be concise and no longer than 4-6 printed pages (about 12 to 18 manuscript pages). Reviews are also peer-reviewed.

Review Process
All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers. Authors cannot nominate reviewers. Only reviewers randomly selected from our database with specialization in the subject area will be contacted to evaluate the manuscripts. The process will be blind review.

Decisions will be made as rapidly as possible, and the journal strives to return reviewers’ comments to authors as fast as possible. The editorial board will re-review manuscripts that are accepted pending revision. It is the goal of the JDAE to publish manuscripts within weeks after submission.

Regular articles
All portions of the manuscript must be typed double-spaced and all pages numbered starting from the title page.

The Title should be a brief phrase describing the contents of the paper. The Title Page should include the authors’ full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

The Abstract should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The Abstract should be 100 to 200 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited. Following the abstract, about 3 to 10 key words that will provide indexing references should be listed.

A list of non-standard Abbreviations should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelled out and introduced in parentheses the first time it is used in the text. Only recommended SI units should be used. Authors should use the solidus presentation (mg/ml). Standard abbreviations (such as ATP and DNA) need not be defined.

The Introduction should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and methods should be complete enough to allow experiments to be reproduced. However, only truly new procedures should be described in detail; previously published procedures should be cited, and important modifications of published procedures should be mentioned briefly. Capitalize trade names and include the manufacturer’s name and address. Subheadings should be used. Methods in general use need not be described in detail.
**Results** should be presented with clarity and precision. The results should be written in the past tense when describing findings in the authors’ experiments. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the Results but should be put into the Discussion section.

**The Discussion** should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

**The Acknowledgments** of people, grants, funds, etc should be brief.

**Tables** should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, including headings and footnotes. Each table should be on a separate page, numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text. The details of the methods used in the experiments should preferably be described in the legend instead of in the text. The same data should not be presented in both table and graph form or repeated in the text.

**Figure legends** should be typed in numerical order on a separate sheet. Graphics should be prepared using applications capable of generating high resolution GIF, TIFF, JPEG or PowerPoint before pasting in the Microsoft Word manuscript file. Tables should be prepared in Microsoft Word. Use Arabic numerals to designate figures and upper case letters for their parts (Figure 1). Begin each legend with a title and include sufficient description so that the figure is understandable without reading the text of the manuscript. Information given in legends should not be repeated in the text.

**References**: In the text, a reference identified by means of an author’s name should be followed by the date of the reference in parentheses. When there are more than two authors, only the first author’s name should be mentioned, followed by ‘et al’. In the event that an author cited has had two or more works published during the same year, the reference, both in the text and in the reference list, should be identified by a lower case letter like ‘a’ and ‘b’ after the date to distinguish the works.

Examples:


References should be listed at the end of the paper in alphabetical order. Articles in preparation or articles submitted for publication, unpublished observations, personal communications, etc. should not be included in the reference list but should only be mentioned in the article text (e.g., A. Kingori, University of Nairobi, Kenya, personal communication). Journal names are abbreviated according to Chemical Abstracts. Authors are fully responsible for the accuracy of the references.

Examples:


**Short Communications**

Short Communications are limited to a maximum of two figures and one table. They should present a complete study that is more limited in scope than is found in full-length papers. The items of manuscript preparation listed above apply to Short Communications with the following differences: (1) Abstracts are limited to 100 words; (2) instead of a separate Materials and Methods section, experimental procedures may be incorporated into Figure Legends and Table footnotes; (3) Results and Discussion should be combined into a single section.

Proofs and Reprints: Electronic proofs will be sent (e-mail attachment) to the corresponding author as a PDF file. Page proofs are considered to be the final version of the manuscript. With the exception of typographical or minor clerical errors, no changes will be made in the manuscript at the proof stage.
Fees and Charges: Authors are required to pay a $550 handling fee. Publication of an article in the Journal of Agricultural Biotechnology and Sustainable Development is not contingent upon the author’s ability to pay the charges. Neither is acceptance to pay the handling fee a guarantee that the paper will be accepted for publication. Authors may still request (in advance) that the editorial office waive some of the handling fee under special circumstances.

All rights Reserved. In accessing this journal, you agree that you will access the contents for your own personal use but not for any commercial use. Any use and or copies of this Journal in whole or in part must include the customary bibliographic citation, including author attribution, date and article title.

Submission of a manuscript implies: that the work described has not been published before (except in the form of an abstract or as part of a published lecture, or thesis) that it is not under consideration for publication elsewhere; that if and when the manuscript is accepted for publication, the authors agree to automatic transfer of the copyright to the publisher.

Disclaimer of Warranties

In no event shall Academic Journals be liable for any special, incidental, indirect, or consequential damages of any kind arising out of or in connection with the use of the articles or other material derived from the JDAE, whether or not advised of the possibility of damage, and on any theory of liability.

This publication is provided “as is” without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability, fitness for a particular purpose, or non-infringement. Descriptions of, or references to, products or publications does not imply endorsement of that product or publication. While every effort is made by Academic Journals to see that no inaccurate or misleading data, opinion or statements appear in this publication, they wish to make it clear that the data and opinions appearing in the articles and advertisements herein are the responsibility of the contributor or advertiser concerned. Academic Journals makes no warranty of any kind, either express or implied, regarding the quality, accuracy, availability, or validity of the data or information in this publication or of any other publication to which it may be linked.
## Table of Contents: Volume 5  Number 6  December 2013

### ARTICLES

**Research Articles**

- **Handling, processing and utilization of milk and milk products in Ezha district of the Gurage zone, Southern Ethiopia**  
  Abebe Bereda, Zelalem Yilma and Ajebu Nurfeta  
  91

- **Effect of locust bean fruit pulp (parkia biglobosa) flour on the quality of wheat biscuits**  
  Zakari U. M., Ajayi S. A. and Hassan A  
  99
A survey study was conducted in Ezha district of Gurage zone to understand the hygienic practices during production and further handling of milk and milk products; and their utilization. One hundred and twenty households were selected based on ownership of dairy cows, milk processing practice and willingness to participate in the study from two agro-ecologies (Dega and Woyna Dega) within the district. None of the respondents washed udder before milking. The majority of women washed the equipments (90.8%) and their hands (71.5%) before milking. *Olea africana* and *Hygenia abyssinica* plant leaves were the most commonly smoking and cleaning plant species in the district. The average volume of milk churned at a time was 6 L. Women preserve butter by mixing with spices such as *Nigella sativa*, *Aframomum angustifolium*, *Trigonela fenum* and *Ocimum hardiens*, while Ayib is preserved with the use of *O. hardiens*. Out of the total monthly milk production (55 L), 13.5 L were consumed, whereas the remaining was accumulated for further processing. Among milk and milk products produced, only butter and Ayib were supplied to local markets. Lack of clean water for cleaning purpose; limited knowledge on hygienic handling of milk and milk products; and unimproved milk processing materials were the three major constraints reported by the respondents according to their importance. Recognizing the importance milk and milk products to the producing household nutrition, health and income, development interventions are required to boost production, improve the quality of the products and efficiency of the traditional milk processing equipment.

**Key words:** Milk and milk products, hygiene, processing, utilization, Ezha, Ethiopia.

*Corresponding author. E-mail: ababfereja@gmail.com*
Smallholder farmers and pastoralists together produce and supply 98% of the total annual milk production of the country (YONAD, 2009). According to CSA (2011), over 85% of the milk produced by rural households is consumed within the producer households with the proportion marketed being less than 7%. The small amount of milk produced by a large number of producers but the low marketable output in Ethiopia poses limitations on the possibilities of exploiting distant but rewarding markets due to high transaction costs arising from transportation and high opportunity costs of labor involved. As reported by Muriuki and Thorpe (2001) the vast majority of milk produced outside urban centers in the country is processed into milk products at household level using traditional technologies.

In areas where the climate is hot and humid, the raw milk gets easily fermented and spoiled during storage unless it is refrigerated or preserved. However, such storage facilities are not readily available in rural areas and cooling systems are not feasible due to lack of the required dairy infrastructure and when available high cost of facilities such as refrigerator for resource poor smallholder producers (O'Mahony and Peters, 1987). In Ethiopia, in general and in the study areas in particular milk, milk products are important for producer family consumption and as a source of income through sale of products such as butter and Ayib (Ethiopian cottage cheese).

Due to small volume of daily milk produced, producers keep milk produced over 3 to 4 days until sufficient amount is accumulated to process into the aforementioned shelf stable products. In the study area, traditional milk production, processing and handling is a typical feature. Traditional milk products are generally reported to be of substandard quality mainly due to inadequate dairy infrastructure such as refrigeration facility and clean water and limited knowledge of the hygienic handling of milk and milk products. This necessitates better understanding of the traditional processes and handling of milk and milk by products, which is a prerequisite for development. Although, milk production represents an important part of the livelihood of the community in Ezha district of the Gurage zone, there is shortage of information with regard to milk processing, handling and utilization.

Understanding the prevailing traditional practices of milk production, processing and storage is of paramount importance to make future improvement interventions. The objectives of the current study were therefore to assess the hygienic conditions during handling and processing, and utilization of milk and milk products in Ezha district of the Gurage zone.

MATERIALS AND METHODS

Study area

The study was conducted between February and March 2010 in Ezha district of the Gurage zone, which is located at 200 km South west of Addis Ababa. The altitude of the district ranges from 1800 to 3098 m above sea level and receives an annual rainfall of 900 to 1600 mm with the mean minimum and maximum annual temperatures of 5 and 38°C, respectively.

Sampling procedure

A random sampling procedure was employed to select sample kebeles and households for the study. The district was first stratified as Dega and Woina Dega agro-ecologies. From a total of 28 Kebeles located in the district 2 Kebeles were randomly selected from each of the two agro-ecologies. A total of 30 households per Kebele that own at least one local milking cow were randomly selected. Thus, a total of 120 (30 households × 4 kebeles) households were interviewed. A semi-structured questionnaire was used to gather the required information on the hygienic practices during handling and processing of milk and milk and milk products, and their utilization.

Data analysis

Both qualitative and quantitative data collected on hygienic practices during milk production, processing and storage at household level were analyzed and summarized using both mean and frequency procedures of SPSS statistical package for social science version 13.

RESULTS and DISCUSSION

Handling practices during milking, milk processing and storage

Generally, proper sanitary milking practices were not followed by the majority of the respondents in the study area. Although, most of the respondents reported to wash their hands and milk vessels before milking their cows, washing of udders was not reported (Table 1). Moreover, milkers dip their fingers in the milking vessel and moistening teats of the cows with the intention of facilitating milking. However, such practice may cause microbial contamination of the milk from the milkers hand. The majority of the respondents (57.2%) had access to river water followed by tap water (28%) and hand dug well water (7.2%) (Table 1). However, the quality of both river and hand dug well waters used for cleaning may not be of the required standard thus can attribute to the poor quality of milk in the area. It is, therefore, important to heat treat water from river and hand dug wells intended for cleaning purpose.

The interviewed households used different utensils for milking, storage and processing. All of the respondents reported to use plastic jar for milking, while clay pot was the only material used for churning (butter-making). As reported by most of the respondents (92%), clay pot is also used for storage of milk until the desired volume is collected for processing. Wondu (2007) reported a similar result where 88% of small-scale producers in Southern Ethiopia used traditional clay pot for fermentation and butter-making. As indicated by the respondents, clay pot keeps milk well at the prevailing high ambient temperature as compared to
Table 1. Handling practices during milking by households in the two agro-ecological zones.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Agro-ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dega (n=60)</td>
</tr>
<tr>
<td>Milk hygienic practice (%)</td>
<td></td>
</tr>
<tr>
<td>Wash udder before milking</td>
<td>0</td>
</tr>
<tr>
<td>Wash hand after milking</td>
<td>95.0</td>
</tr>
<tr>
<td>Wash milking utensil with hot water</td>
<td>80</td>
</tr>
<tr>
<td>Source of water for cleaning milk utensils (%)</td>
<td></td>
</tr>
<tr>
<td>Tap water</td>
<td>10</td>
</tr>
<tr>
<td>Hand dug well water</td>
<td>3.3</td>
</tr>
<tr>
<td>River water</td>
<td>86.7</td>
</tr>
<tr>
<td>Milk utensils used for milking (%)</td>
<td></td>
</tr>
<tr>
<td>Plastic jar</td>
<td>100</td>
</tr>
<tr>
<td>Nickel</td>
<td>10</td>
</tr>
<tr>
<td>Milk utensils used for storage (%)</td>
<td></td>
</tr>
<tr>
<td>Clay pot</td>
<td>88.3</td>
</tr>
<tr>
<td>Plastic jar</td>
<td>16.7</td>
</tr>
<tr>
<td>Milk utensil used for churning (%)</td>
<td></td>
</tr>
<tr>
<td>Clay pot</td>
<td>100</td>
</tr>
</tbody>
</table>

n= Number of observations.

plastic containers.

The production of milk of acceptable hygienic quality for consumers requires good hygienic practices. One of the major factors affecting the quality of dairy products is related to the practice of proper milking procedures and cleanliness of the milking utensils (Almaz et al., 2001). About 30% of farmers reported to rub milk storage vessels with leaves of shrubs such as O (Kosso in Amharic), Sida tenuicarpa Vollesen (Ojaja in the local language), Odaterk Conyza spinosa (Odaterk), Olea africana (Weira), and Korekonda (maize cob) and wash with water before use. Washing is commonly followed by drying and smoking the containers with embers of wood sprinters of plants specifically used for this purpose (Hygenia abyssinica, Sida tenuicarpa Vollesen, O. africana, maize cob, Thymus vulgaris, Enset fiber, Conyza spinosa and Thymus schimperi are the most commonly used). Procedures of cleaning and disinfection of milking utensils prior to milk collection reported herein were similar to previous results from Ethiopia (Sintayehu et al., 2008).

Reasons for smoking milk containers using different parts of various plant species as reported by the respondents were similar to earlier reports in Ethiopia (Lemma et al., 2004; Yitaye, 2008). Smoking is also reported to give a good flavor to the product and disinfect the vessels, thereby reducing the microbial load and therefore extending the shelf life of the product. As reported by Mogessie and Fekadu (1993), smoked containers tend to lower the microbial load of milk as compared to unsmoked containers.

Processing milk and shelf life of milk and milk products

As it is the case under smallholder setting in other rural areas of Ethiopia, naturally fermented milk is the basis of processing milk into more shelf stable fermented milk products in the present study area. The major milk products produced in the study area were Ergo (Ethiopian naturally fermented milk), traditional butter (Kibe), traditional ghee (Neter Kibe), cottage cheese (Ayib), sour defatted milk (Arrera), and whey (Aguat). According to most of the respondents, milk is fermented for the main reason that the daily production is small and to get the volume that justifies processing (primarily churning for butter-making), the daily milk yield should be accumulated over a few days. In this process, milk ferments naturally at the prevailing tropical ambient temperatures.

In the rural Ethiopia, in general and in the study area in particular, milk processing and other household activities are almost always the responsibility of women. In the Woina Dega area, the majority of the women (70%) process the milk twice per week followed by once per week (30%), while 53.4% the women around Dega area process their milk twice per week, whereas the remaining 38 and 8% of the respondents reported to process once per week and once fortnightly, respectively (Table 2).

Generally, high ambient temperature favors natural fermentation and therefore, due to the relatively high ambient temperature in the Woina Dega areas, producers in these areas processed milk at higher frequency as
Table 2. Milk processing practices (%) in the two agro-ecological zones.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Agro-ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dega (n=60)</td>
</tr>
<tr>
<td>Processing of milk (%)</td>
<td>100</td>
</tr>
<tr>
<td>Processing frequency (%)</td>
<td></td>
</tr>
<tr>
<td>Twice/week</td>
<td>53.4</td>
</tr>
<tr>
<td>Once/week</td>
<td>38.3</td>
</tr>
<tr>
<td>Once/two week</td>
<td>8.3</td>
</tr>
<tr>
<td>Volume of milk churned at a time (liter)</td>
<td>$6.4\pm2.1^a$</td>
</tr>
<tr>
<td>Reasons for processing of milk (%)</td>
<td></td>
</tr>
<tr>
<td>To generate more income</td>
<td>85</td>
</tr>
<tr>
<td>To increase shelf life</td>
<td>88.3</td>
</tr>
<tr>
<td>To purchase agricultural commodity</td>
<td>91.7</td>
</tr>
<tr>
<td>Cultural reluctance towards consumption of fresh milk</td>
<td>7</td>
</tr>
<tr>
<td>Consumer preference</td>
<td>3.3</td>
</tr>
</tbody>
</table>

n= Number of observation.

Table 3. Milk products processing practice in the study area.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Agro-ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dega (n=60)</td>
</tr>
<tr>
<td>Amount of butter recovered in a single churn (kg)</td>
<td>$0.34\pm0.12$</td>
</tr>
<tr>
<td>Amount of Ayib in single churn (kg)</td>
<td>$1.07\pm0.11$</td>
</tr>
<tr>
<td>Volume of milk used to produce kg of butter (lit)</td>
<td>$21\pm1.6$</td>
</tr>
<tr>
<td>Volume of defatted sour milk used to produce kg of Ayib</td>
<td>$6\pm 0.56$</td>
</tr>
</tbody>
</table>

compared to those in the Dega areas. As observed in the present study, about 93% of the respondents process milk to extend the shelf life of the product followed by generation of income to purchase agricultural commodities (76.7%) and to fulfill other day to day necessities (76.7%) (Table 2). Ayantu (2006) in her report in Delbo watershed area of the Wolayta zone also indicated that milk is processed in order to increase the family’s income, diversify the products for consumption and to increase the shelf life of the products. Kassahun (2008), however, reported that milk is primarily processed whenever there is market constraint for fresh milk in the Ada’a district.

**Butter making**

All of the respondents produced traditional butter from naturally fermented whole milk. While churning, traditional churns are covered with materials such as dry Enset pseudo stem sheath and/or a piece of plastic material, which is stretched over the opening of the churn and securely tied. The average milk churned at a time observed was about 6 L at household level though markedly (P<0.01) varied between the two agro-ecologies (Table 3). Zelalem and Ledin (1999) also reported a similar value (6.4 L) in the central highlands of Ethiopia. However, lower values of 2.1 L (Ayantu, 2006) and 1.97 L (Rahel, 2008) were reported in the Wolayta zone. The amount of butter obtained from a single churn in the current study (0.25 kg) (Table 3) was higher than that reported in the Wolayta zone (0.13 kg) (Rahel, 2008) and (0.16 kg) (Ayantu, 2006), which is likely to be attributed to the difference in the volume of milk churned at a time.

In the present study, the amount of milk required to produce one kg of butter was 22.32 L (Table 3). This value is comparable with that of earlier reports of 25 kg in Borena plateau (Coppock, 1994), 20 to 22 L in rural areas of Southern Ethiopia (Fekadu, 1994) and 21 L in the central highlands of Ethiopia (Zelalem and Ledin, 1999). However, lower values were also reported; 15 to 20 L in Awassa (Wondu, 2007), 15.79 L in the Wolayta zone (Rahel, 2008), 16.7 L in East Wollega (Alganesh, 2002), and 17.1 L in East Shewa zone (Lemna et al., 2004). Such variations are likely attributed to the fat content of the milk used which in turn is a function of breed. Milk of local zebu cattle breeds has higher fat content as compared with that of pure exotic and crossbred cows.

All of the interviewed farmers used different spices as means of preservation for traditional butter. The major spices used for this purpose were Kosere (Ocimum hardiense), Korerima (Aframomum angusti-folium), Tikur azmud (Nigella sativa) and Abish (Trigonela fenum). As
Table 4. Production and consumption of milk and milk product in the two agro-ecological zones.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Agro-ecology</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dega (n=60)</td>
<td>Woina Dega (n=60)</td>
</tr>
<tr>
<td>Milk (%)</td>
<td>68.3</td>
<td>46.7</td>
</tr>
<tr>
<td>Butter</td>
<td>68.3</td>
<td>96.7</td>
</tr>
<tr>
<td>Ergo</td>
<td>3.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Ayib</td>
<td>93.3</td>
<td>95.0</td>
</tr>
<tr>
<td>Whey</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Average milk produced and consumed (lit) per month (±S.E)

<table>
<thead>
<tr>
<th></th>
<th>Dega (n=60)</th>
<th>Woina Dega (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced</td>
<td>57.6±3.6</td>
<td>52.2±3.2</td>
</tr>
<tr>
<td>Consumed</td>
<td>18.73±2.9a</td>
<td>8.37±2.6b</td>
</tr>
<tr>
<td>Daily milk consumption</td>
<td>0.62±0.09a</td>
<td>0.28±0.056b</td>
</tr>
</tbody>
</table>

Average Ayib produced and consumed (kg) per month (±S.E)

<table>
<thead>
<tr>
<th></th>
<th>Dega (n=60)</th>
<th>Woina Dega (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayib produced</td>
<td>5.96±0.63</td>
<td>7.1±0.7</td>
</tr>
<tr>
<td>Ayib consumed</td>
<td>3.37±0.35a</td>
<td>4.95±0.51b</td>
</tr>
</tbody>
</table>

Average butter produced and consumed (kg) per month (±S.E)

<table>
<thead>
<tr>
<th></th>
<th>Dega (n=60)</th>
<th>Woina Dega (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter produced</td>
<td>1.9±0.18</td>
<td>2.05±0.15</td>
</tr>
<tr>
<td>Butter consumed</td>
<td>0.94±0.12a</td>
<td>1.73±0.15b</td>
</tr>
</tbody>
</table>

Row mean bearing with different superscripts letters are significantly different from each other (P<0.05). S.E = Standard error.

reported by the respondents, the traditional butter can be stored at ambient temperatures on average for about one year without losing its desired flavour and taste.

Ethiopian cottage cheese (Ayib) making

The amount of Ayib obtained at a time in this finding was 1.05 kg, which is comparable between the two agro-ecologies (Table 3). This value is in agreement with the 6 L reported by Zelalem and Ledin (1999) in the central highlands of Ethiopia. However, Rahel (2008) reported a higher value (8.69 L) in Wolayta zone. The spices mainly used as a preservatives to extend shelf life of Ayib were Kosereite (O. hardiense), Tikure azmude (N. sativa), Korerima (A. angustifolium), Tena Adam (Ruta chalepensis) and Abish (Trigonela fenum) and in addition to these salt is also used to extend the shelf life of Ayib.

Consumption and utilization of milk and milk products

Like in most other rural areas of Ethiopia, the common milk products manufactured and consumed in the current study areas include fresh whole milk, whey (Aguate), butter, Ayib and ghee (Niter Kibe). Out of the total monthly milk production (55 L) per household, about 13.5 L was used for consumption within the producing households, the rest being left to be processed in to more value added products mainly butter and Ayib that have better shelf life and fetch better market price (Table 4). In the present study, about 68.3 and 47% of the respondents in the Dega and Woina Dega areas, respectively, used whole milk for consumption. Contrary to this finding, consumption of raw milk in the Wolayta zone is not a usual practice rather in most cases the small amount of milk produced daily is accumulated over a few days to manufacture the butter that fetches a better price (Ayantu, 2006).

Butter of the Wolaita zone is one of the most preferred butter for its taste not only in the area of production but also all the way up to Addis Ababa. Out of the total butter production (1.9 kg) per household per month, about 1.33 kg was used for consumption (Table 4). About 68.3 and 96.7% of the respondents in the Dega and Woina Dega areas, respectively, used butter for producer household consumption.

Butter consumption in the Woina Dega area was 1.73 kg/month/household, which was significantly (P<0.01) higher than that consumed by households in the Dega area (0.94 kg/month/household). This could be due to the common practice of accompanied butter while consuming the homemade flat bread (Kocho) made from Enset (Ensete ventricosum) in the Woina Dega area.

The mean monthly production of Ayib per household in the district was 6.6 kg. Out of this total monthly production, 2.16 kg is consumed within the household. The average monthly production per household observed in this study was much higher than 0.31 kg reported in the Ada’a Woreda (Kassahun, 2008) and 1.2 kg in Wolayta zone (Rahel, 2008).
Table 5. Marketing of milk and milk products in the two agro-ecological zones.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Agro-ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dega (n=60)</td>
</tr>
<tr>
<td><strong>Average butter and Ayib sold per month in kg (±S.E)</strong></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>0.96±0.16</td>
</tr>
<tr>
<td>Ayib</td>
<td>2.54±0.38</td>
</tr>
<tr>
<td><strong>Average price of butter and Ayib per kg (±S.E)</strong></td>
<td></td>
</tr>
<tr>
<td>Butter price</td>
<td>57.8±10.5</td>
</tr>
<tr>
<td>Ayib price</td>
<td>15.11±0.28a</td>
</tr>
<tr>
<td><strong>Selling practices (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Butter selling practice (%)</td>
<td>60</td>
</tr>
<tr>
<td>Ayib selling practice (%)</td>
<td>76.7</td>
</tr>
<tr>
<td>Milk selling practice (%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Reasons for not selling milk (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Cultural restriction</td>
<td>60</td>
</tr>
<tr>
<td>Lack of market</td>
<td>28.4</td>
</tr>
<tr>
<td>Scarcity of milk</td>
<td>85</td>
</tr>
</tbody>
</table>

Row mean bearing with different superscripts letters are significantly different from each other (P<0.05). S.E= Standard error.

Marketing of milk and milk products

As observed during the current study, the sale of fresh whole milk was not a common practice (Table 5). Among different multiple reasons, inefficient milk production (78.3%) and cultural restrictions (taboos) toward selling fresh whole milk (53.3%) followed by lack of market (20%) are the most common reasons reported (Table 5). A similar situation was reported in Eastern Wollega where about 21.3 and 19% of the women did not sell fresh milk mainly due to scarcity and cultural reasons, respectively (Alganesh, 2002). On the other hand, about 60 and 35% of the respondents in the Dega area and Woina Dega area, respectively, stated that they sold butter, while the rest of the respondents never sold, while 29% of the respondents did not sell Ayib.

In the study areas, Ayib is the most important marketed product. Ayib sold per household per month was 2.4 kg (Table 5). This result is lower when comparable with results (3.4 kg) of Rahel (2008). The average weight of the butter sold per household per month in this district was 0.64 kg (Table 5). Significant difference (P<0.05) was observed between the Dega and Woina Dega areas in average monthly butter sold per household where households in the Dega area sold significantly high amount of butter. This difference could be attributed to the lower consumption of butter per household in the same (Table 5). The average butter sold per household per month in the current study is much less than the amount (7.2 kg) reported by Rahel (2008).

The average prices of Ayib and butter were 16 birr and 52 birr/kg, respectively (Table 5). The mean price of Ayib in the Woina Dega area was 17 birr, which is significantly higher (P<0.001) than that of the Dega area (14 birr) (Table 5). The price base of the product is subjective and depends on weight estimation by the customers who estimate by putting them on their hands. The price of Ayib reported in the current study is comparable with that (15 birr/kg) reported by Rahel (2008) and Zewdie (2010) (16.5 birr/kg) in Sebeta. Kassahun (2008) and Zewdie (2010), however, reported lower prices in urban areas of Lume (12 birr/kg) and Zeway (13 birr/kg), respectively.

In Ethiopia, studies indicate that butter prices differ from place to place. Zewdie (2010) reported the price of butter in Sebeta, Ziway, Debre Berhan and Jimma to be 75, 66, 61 and 60 birr/kg, respectively, during the dry season. As indicated by Zelalem and Ledin (1999), such price differences may arise from factors such as access to better market in urban areas as compared to rural areas in the central high lands of Ethiopia. In addition, Zewdie (2010) indicated that price of butter and Ayib differences may arise due to season, highest price in the dry season than wet season. This could be due to the good supply of butter during the rainy season owing to better grass availability following the rain, which leads to high production of milk.

Constraints of handling, processing and utilization of milk and milk products

The major constraints pertaining to milk handling, processing and utilization as reported by the respondents in the Ezha district of the Gurage zone are summarized in Table 6. Close to 80% of the respondents reported lack of clean water for cleaning purpose, limited knowledge on the hygienic handling of milk and milk products and unimproved milk processing materials to be the three major constraints listed according to their importance.
Table 6. Major constraints to milk handling, processing and utilization

<table>
<thead>
<tr>
<th>Variable</th>
<th>% of total respondents</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of clean water</td>
<td>37</td>
<td>1st</td>
</tr>
<tr>
<td>Limited knowledge</td>
<td>24</td>
<td>2nd</td>
</tr>
<tr>
<td>Unimproved milk processing materials</td>
<td>17</td>
<td>3rd</td>
</tr>
<tr>
<td>Lack of access and high price of cooling facilities</td>
<td>11</td>
<td>4th</td>
</tr>
<tr>
<td>Lack of electricity</td>
<td>7</td>
<td>5th</td>
</tr>
<tr>
<td>Low milk production</td>
<td>4</td>
<td>6th</td>
</tr>
</tbody>
</table>

Conclusion

Dairy production is an important and integral part of the crop-livestock mixed production system in Ethiopia in general and in the study area in particular; milk processing is a culture of the community of the Ezha district of the Gurage zone and milk products have various social, nutritional and economic values. The milk production system of the study areas can generally be characterized by small herd size with no improved crossbred cattle and poor productivity of cows with very low milk yield, and long calving interval and lactation length. Although milk and milk products are essential, the majority of the respondents did not practice recommended hygienic practices (such as hand and udder washing) during milking and further handling (processing, storage and marketing) of milk and milk products.

Producing milk and milk products of not only acceptable quality but also of high quality are important from consumer health point of view and may also lead to increased demand and income to producers. Among others, lack of clean water for cleaning purpose (milkers’ hand, cows udder, and containers and equipment of milk and milk products); limited knowledge on the hygienic handling of milk and milk products; and unimproved milk processing materials in terms of capacity (volume), time elapsed to recover the intended milk product and the quantity of final product obtained from a given volume of raw material used (milk, naturally fermented milk, defatted sour milk) are the three major constraints reported by the respondents according to their importance.

Recognizing the importance of dairy farming to the livelihood of the community in question and milk and milk products to the producing household nutrition, health and income, development interventions are required to boost production, improve the quality of the products and efficiency of the traditional milk processing equipment. Such interventions coupled with linking producers with other important actors in the dairy value chain of the study district will definitely improve the benefits that producers should get from the dairy sub sector.

ACKNOWLEDGEMENTS

The authors are grateful for the financial support provided by Debre Berhan University under Ministry of Education, Ethiopia.

REFERENCES


Effect of locust bean fruit pulp (parkia biglobosa) flour on the quality of wheat biscuits

Zakari U. M.*, Ajayi S. A. and Hassan A.

Department of Food Technology Kaduna Polytechnic, P. M. B. 2021, Kaduna, Nigeria.

Accepted 5 December, 2013

Composite biscuits were produced from blends of wheat flour and African locust bean fruit pulp flour. The wheat/locust bean fruit pulp flours were mixed in the ratio of 100:0, 90:10, 85:15, 80:20 and 70:30%, respectively. The physical characteristics of the biscuits ranged in value, with diameter from 6.10 to 6.35cm, height from 1.08 to 1.20 cm, weight from 15.20 to 16.40 g, spread ratio from 4.90 to 5.88 and break strength from 530 to 820 g. Protein content ranged from 8.25 to 9.61%, fat from 0.62 to 1.19%, ash from 3.25 to 3.50%, crude fiber from 1.70 to 3.70% and carbohydrate from 69.93 to 71.75%. The vitamin C ranged from 400 to 460 mg/100 g. Protein content, fat and carbohydrate content decreased, while vitamin C, ash and crude fiber contents augmented with increased addition of locust bean fruit pulp flour. Sensory panelists rated the products highly for all the parameters investigated (P < 0.05). The biscuit with 10% substitution was rated next to the control (100% wheat biscuits) in the parameters tested. Acceptable biscuits can therefore be produced from blends of wheat/locust bean fruit pulp flour up to 20% substitution level.

Key words: Biscuit, flour, locust bean, wheat.

INTRODUCTION

Biscuits may be regarded as a form of confectionery, dried to a very low moisture content. Biscuits are usually produced from cereal flours (mainly wheat) and consumed extensively all over the world. According to Agu et al. (2007), a biscuit is defined as a small thin crisp cake made from unleavened dough. Okaka (1997) described the biscuits as a mixture of flour and water, often with the addition of fat, sugar and other ingredients, mixed together into dough which is rested for a period of time and then passed between rollers to make a sheet that is cut in smaller pieces and baked. Biscuits are ideal for nutrient availability, palatability, compactness and convenience. They differ from other baked products like bread and cakes because of low moisture content, comparative freedom from microbial spoilage and long shelf-life (Mian et al., 2009). Biscuits may be classified either by the degree of enrichment and processing or by the method adopted in shaping them. Based on the enrichment criterion, biscuits may be produced from hard dough, soft dough or from batter (Fayemi, 1981).

The nutritional content however varies with the type of flour used. Soft wheat flour is the best flour for biscuit making, because of the composition of its storage proteins, gliadins and glutenins, which undergo hydration in the presence of water, salt and sugar. These proteins form a visco-elastic matrix known as gluten, which is responsible for the rising nature of dough and permits substantial increase in the volume of baked product with its gas retention capability (Agu et al., 2007).

Nigeria, a tropical country, cannot grow wheat in commercial quantity due to its hot climatic condition. Therefore, for the survival of biscuits and other confectionery products, the use of locally available grains or legumes to substitute wheat flour is essential (Kent, 1984). A lot of work involving the use of non-wheat flour
from various cereals and legumes has been done to substitute wheat in baked products (Eneche, 1999, Nochera and Caldwell, 1992). The African locust bean (Parkia biglobosa) fruit pulp, which has been found to have good nutritional value (prot 6.56, fat 1.8, CHO 67.30, ash 4.18 and crude fibre 11.75%) and low anti-nutrients/toxins (phytic acid 60.00, crude saponin 17.80 and tannin 18.00 mg/100 g), has not been widely exploited as raw materials in confectionery products (Gernah et al., 2007; Akoma et al., 2002, Musa et al., 2005).

The aim of this study was to produce biscuits from various blends of wheat flour and African locust bean fruit pulp flour and to evaluate the physical, chemical and sensory properties of the developed products.

MATERIALS AND METHODS

Source of raw materials

This research was carried out at the department of Food Technology, Kaduna Polytechnic, Kaduna, Nigeria. The locust bean fruit pods were bought from Kasuwan Magani, a village in Chukun Local Government of Kaduna State. Wheat flour (Dangote brand), baking fat (Margarine), granulated sugar, powdered milk, eggs, baking powder and salt were bought from a commercial store in Abubakar Gumi Central Market, Kaduna. All the equipment used was from the department of Food technology, Kaduna Polytechnic, Kaduna. The chemicals were of analytical grade and obtained from the laboratory of the department of Food Technology, Kaduna Polytechnic, Kaduna.

Preparation of locust bean fruit pulp flour

The preparation of locust bean fruit pulp flour was done using the method of Gernah et al. (2007). The outer brown cover of the pods was manually stripped open and the yellow fruit pulp was separated from seeds embedded within the pulp. The yellow pulp was dried in a hot air oven (model T1211, Genlab, Widnes, UK) at 60°C for 9 h to a moisture content of 10%. The dried powder was milled with a laboratory hammer mill (Christy Hunt, UK), and sieved through a 0.5 mm mesh screen to obtain a fine flour, which was packaged in low density polyethylene bags, and stored in air-tight container at room temperature.

Preparation of biscuits

The ingredients used were wheat flour, locust bean fruit pulp flour, baking fat, granulated sugar, baking powder, milk powder, salt, egg (whole egg) and water. Wheat flour and the locust bean fruit pulp flour were the ingredients varied in the research.

To prepare blends of different proportions of wheat flour (WF) and locust bean fruit pulp (LBFP), the WF/LBFP flours were mixed in the ratio of 100:0, 90:10, 85:15, 80:20 and 70:30%, respectively. Control biscuits with wheat flour and experimental biscuits with flour blends were prepared using a modified method of Jane and Emma (1998). The ingredients were mixed for 10 min to form dough, kneaded into stiff dough. The dough was rolled out on a sheeting board to a sheet of uniform thickness of about 0.4 cm, and the sheet was stamped out in circular shapes of about 5.8 cm diameter, using a biscuit cutter. The biscuit cuts were then removed and allowed to cool on a rack, packaged in low-density polyethylene bags and kept in an air-tight container.

Analytical determinations

Physical properties of the biscuits such as the diameter, the weight and the height were determined by the AACC method (AACC, 1995). The spread ratio was determined by the method of Gomeaz et al. (1997) and was calculated as diameter/height. The break strength was determined using break strength device by the method of Okaka and Isieh (1990). A biscuit of known thickness (0.4 cm) was placed centrally between two parallel metal bars (3 cm apart), and weights were added on the biscuit until it snapped. The last weight that caused the breaking of the biscuit was regarded as the break strength of biscuit. Proximate composition was determined by AOAC methods (protein (micro-kjedahl, 2005); fat (Soxhlet method, 2005); ash (muffle furnace, 2005), fibre (acid digestion, 2005) and moisture content hot air oven, 2005). The carbohydrate content was determined by difference as described by Ihekoronye and Negoddy (2005); the vitamin C was analysed by Indophenol method (AOAC, 2005). Sensory evaluation was conducted on both the control and experimental biscuits. A total of fifteen untrained panelist drawn from Kaduna Polytechnic, Kaduna, based on their familiarity with the product, were used for the evaluation. The parameters investigated include, taste, colour, aroma, texture and general acceptability. A 7-point hedonic scale was used, in which 1 represents dislike extremely and 7 represents like extremely. The resulting data were tested using the analysis of variance (ANOVA) to detect significant differences among treatment. Tukey’s test was used to separate the means, when significant differences existed (Iwe, 2002).

RESULTS AND DISCUSSION

The results of the assessment of the physical properties of the biscuits are presented in Table 1. The diameter of the biscuits varied from 6.10 to 6.35 cm, the height ranged from 1.08 to 1.20 cm and the weight of the

### Table 1. Physical properties of the biscuits.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Diameter (cm)</th>
<th>Height (cm)</th>
<th>Weight (g)</th>
<th>Spread ratio</th>
<th>Break strength (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% WF</td>
<td>6.10±0.00</td>
<td>1.20±0.02</td>
<td>15.21±0.20</td>
<td>4.90±0.9</td>
<td>820±0.40</td>
</tr>
<tr>
<td>90WF:10LBFP</td>
<td>6.22±0.50</td>
<td>1.10±0.00</td>
<td>15.20±0.40</td>
<td>5.65±0.00</td>
<td>620±0.30</td>
</tr>
<tr>
<td>85WF:15LBFP</td>
<td>6.27±0.30</td>
<td>1.10±0.00</td>
<td>15.20±0.40</td>
<td>5.70±0.01</td>
<td>540±0.60</td>
</tr>
<tr>
<td>80WF:20LBFP</td>
<td>6.30±0.31</td>
<td>1.10±0.00</td>
<td>16.35±0.60</td>
<td>5.72±0.01</td>
<td>540±0.50</td>
</tr>
<tr>
<td>70WF:30LBFP</td>
<td>6.35±0.41</td>
<td>1.08±0.01</td>
<td>16.40±0.50</td>
<td>5.88±0.80</td>
<td>530±0.51</td>
</tr>
</tbody>
</table>

NF = Wheat flour. LBFP = Locust bean fruit pulp flour.
biscuits ranged from 15.20 to 16.40 g, while the spread ratio ranged from 4.90 to 5.88. The wheat bread (100% wheat flour) had a lower spread ratio (4.90) than the other samples, which compares favorably with the work of Agu et al. (2007). This is because the starch polymer molecules are highly bound with granules and swelling is limited when heated. On cooling, the starch rapidly forms a rigid gel with capacity characteristics of large molecular aggregates. The formation of large molecular aggregates may not be unconnected with the gluten structure which is very strong resulting to high degree of contraction of the biscuit. The wheat flour biscuit (100% wheat flour) exhibited the highest break strength (820g), while all the composite biscuits fractured under a load of 700g. The high break strength observed for the 100% wheat flour biscuit compared favorably with work of Okaka and Isieh (1990).

The result of chemical composition analysis is shown in Table 2. The average protein contents of the biscuits ranged from 8.25 to 9.61%. A decrease in protein content was observed with increased addition of LBFP flour. The decrease could be attributed to substitution effect, since the LBFP flour has lower protein content. However, the biscuits made from the blends still maintained a reasonable protein level (8.25 to 8.85%). There were slight increases in moisture as the level of locust bean fruit pulp flour increased, which may be attributed to the initial high moisture content of locust bean fruit pulp flour. The increase in moisture content of the biscuits from the blends could also be due to high sugar content of locust bean fruit pulp flour, which made the biscuits more hygroscopic (Gernah et al., 2010).

The ash content (3.25 to 3.50%) increased with increased addition of LBFP flour, thus indicating high level of minerals in LBFP flour. Crude fibre of the products also increased. Since the fibre level was high, the biscuits produced from the blends could be considered as functional biscuits: their fibre will add bulk to the food and thereby facilitate bowel movement and help in preventing many gastrointestinal diseases in man (Sudha et al., 2007). There were slight decreases in the carbohydrate content of the biscuits, but the decrease was not significant. The carbohydrate ranged between 69.93 and 75% (70:30 composite and 100:0 wheat flour only, respectively). Vitamin C increased with increased addition of locust bean fruit pulp flour, as a result of the addition of LBFP, which is characterized by high vitamin C content. The result of sensory evaluation is shown in Table 3.

Table 2. Chemical composition of the biscuits.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Protein (%)</th>
<th>Moisture (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Crude fibre (%)</th>
<th>Carbohydrate (%)</th>
<th>Energy (Kcal)</th>
<th>Vit. C (Mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% WF</td>
<td>9.61±0.16</td>
<td>12.5±0.05</td>
<td>1.19±0.00</td>
<td>3.25±0.02</td>
<td>1.70±0.00</td>
<td>71.75±0.01</td>
<td>336.15</td>
<td>400</td>
</tr>
<tr>
<td>90WF:10LBFP</td>
<td>8.85±0.22</td>
<td>13.0±0.05</td>
<td>0.98±0.21</td>
<td>3.27±0.01</td>
<td>3.03±1.33</td>
<td>70.87±0.12</td>
<td>327.70</td>
<td>420</td>
</tr>
<tr>
<td>85WF:15LBFP</td>
<td>8.63±0.23</td>
<td>13.5±0.12</td>
<td>0.85±0.13</td>
<td>3.28±0.01</td>
<td>3.32±0.29</td>
<td>70.42±0.06</td>
<td>323.85</td>
<td>440</td>
</tr>
<tr>
<td>80WF:20LBFP</td>
<td>8.40±0.15</td>
<td>13.7±0.14</td>
<td>0.73±0.12</td>
<td>3.37±0.09</td>
<td>3.45±0.13</td>
<td>70.35±0.07</td>
<td>321.57</td>
<td>440</td>
</tr>
<tr>
<td>70WF:30LBFP</td>
<td>8.25±0.10</td>
<td>14.0±0.06</td>
<td>0.62±0.11</td>
<td>3.50±0.13</td>
<td>3.70±0.25</td>
<td>69.93±0.09</td>
<td>308.30</td>
<td>460</td>
</tr>
</tbody>
</table>

Table 3. Sensory evaluation of the biscuits.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Colour</th>
<th>Taste</th>
<th>Texture</th>
<th>Aroma</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>100WF</td>
<td>6.7a</td>
<td>6.5a</td>
<td>5.9a</td>
<td>6.2a</td>
<td>6.2a</td>
</tr>
<tr>
<td>90WF:10LBFP</td>
<td>5.7a</td>
<td>6.1a</td>
<td>5.7a</td>
<td>5.9a</td>
<td>6.1a</td>
</tr>
<tr>
<td>85WF:15LBFP</td>
<td>5.4a</td>
<td>6.0a</td>
<td>5.2a</td>
<td>5.2a</td>
<td>5.5a</td>
</tr>
<tr>
<td>80WF:20LBFP</td>
<td>5.4b</td>
<td>5.7a</td>
<td>5.4a</td>
<td>5.4a</td>
<td>5.2a</td>
</tr>
<tr>
<td>70WF:30LBFP</td>
<td>4.3b</td>
<td>5.4a</td>
<td>4.7a</td>
<td>4.7a</td>
<td>4.7b</td>
</tr>
</tbody>
</table>

Values with the same letter(s) in the same column are not significantly different at 5% level of significant.
The results indicate that the products made from the blends were highly rated for all the parameters (colour, taste, texture, aroma and overall acceptability) investigated. There was significant difference ($P < 0.05$) in colour, possibly because of the high level of sugar of the LBFP flour, which caramelized during baking. The sensory results indicated that biscuits products could be highly accepted up to 20% substitution level.

### Conclusion

This research showed that acceptable biscuits could be produced with blends of locust bean fruit pulp flour and wheat flour, up to 20% substitution level. Such biscuits could be regarded as functional biscuits because of the high fibre level.

### REFERENCES

UPCOMING CONFERENCES

3rd Biotechnology World Congress, Dubai, UAE

International Conference on Plant Transformation Technologies III, Vienna, Austria
February 2014
3rd Biotechnology World Congress, Dubai, UAE

International Conference on Plant Transformation Technologies III, Vienna, Austria
Journal of Agricultural Biotechnology and Sustainable Development

Related Journals Published by Academic Journals

- Journal of Plant Breeding and Crop Science
- African Journal of Agricultural Research
- Journal of Horticulture and Forestry
- International Journal of Livestock Production
- International Journal of Fisheries and Aquaculture
- Journal of Cereals and Oilseeds
- Journal of Soil Science and Environmental Management
- Journal of Stored Products and Postharvest Research