TRANSNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

2013 / April

***by* T-Institute**

April edition vol. 3, No. 4

ISSN: 1857-8047

Table Of Contents:

A NEW INTERNATIONAL RESEARCH IN SONOCHEMISTRY OF DAIRY PRODUCTS

Muthupandian Ashokkumar, PhD

University of Melbourne, Australia

Natalia Tihomirova, PhD

Moscow State University of Food Production, Russia

Olga Krasulya, PhD

Sergey Shestakov, PhD

Moscow State University of Technology and Management, Russia

Boris Krasulya

M.V. Lomonosov Moscow State University, Russia

Eduard Smeshek, PhD

Polessky state university, Belarus

Raul Rink

Oil Tech Production OY, Estonia

Abstract:

The paper describes the results of recent research in the field of sonochemistry of the dairy products which was conducted from Australia, Russia, Belarus and Estonia. This work is related to the technology of preparation of composite formula milk from natural milk, vegetable oils and dry milk products with cavitation treatment of water used. She is devoted to obtaining a homogeneous mixtures of dairy semiproducts, from which subsequently produce dairy products such as cottage cheese or cheese, where most of the water is removed with sera. It is shown that sonochemical water treatment has a positive effect on the entire process and its outcome.

Keywords: Sonochemistry, water conditioning, dairy semiproducts

1. Introduction

The success of manufacturers of the foods depends on how they manage to make up for water loss incurred in raw materials during it storage and primary processing. Binding of

water with biopolymers - their hydration - one of the major problems of the food industry. Even manufacturers of solid products like bread or products from chopped meat, are added to the raw materials, from which they made up to a quarter of water by weight. History tells us that the first time the rate of return received at the expense of water in foods, were legalized by Henry IV English, to stop the discords the millers, who had not yet learned to moisten the grain before grinding, with the bakers, who knew how to manage moisture bread.

The dairy industry is one of the leading in food industry on the use of artificial hydration, because in it sometimes taken keep milk in dried form and restore to it if necessary by water. Even despite the fact that the water in many foods made from milk is removed in the process of cooking as serum, but it has an important impact on the quality of finished products. The water in the milk, as well as in the composition of fluids that are produced by a living organism, has special properties. Before get to them the water is passes through biological membranes, is disintegrated on the individual molecules, is involved in protein synthesis and increases hydrophilicity of aminoacids. Water used in the restoration of dry dairy ingredients may be close to a state in which it is in natural milk, when the energy of its connection with the protein is maximum. The very same hydration as any reversible chemical reaction in accordance with the law Le Chatelier-Braun is more intense in the energetically favorable for it conditions. Because hydration is - an exothermic process, it happens when the shell of protein is also constructed of individual water molecules, unrelated to the start of the reaction (Kuntz I.D., 1975).

2. Review of the technical and patent literature

Application of cavitation in the processing of milk is already known. For example, for this apply a hydrodynamic cavitation in devices rotary-pulsatile type, which make the pasteurization and homogenization of milk. Specialists from the University of Mexico have developed a method of disinfection of milk. It is based on cavitation and does not require heating the entire fluid, but can also replace and pasteurization.

Many useful reactions initiated by ultrasound in the milk, occur on base the mechanisms of the effects on the supramolecular structure of biopolymers (Ashokkumar M., 2010). So considers researchers of food sonochemistry from Food Science Australia. But while forming during the pyrolysis of gas mixture in cavitation bubbles free radicals, and also the synthesis and diffusion into liquids the peroxy compounds undesirable. This is established by the authors (Tikhomirova N., 2011; Shestakov S., 2012).

Also at the Institute of Chemical Physics RAS named N. Semenov was measured frequently is used now in studies of state moisture in food substances the proton magnetic relaxation in distilled water subjecting its to preliminary processing in a sonochemical reactor. They showed that the spin-spin relaxation with a characteristic time of T2 acquires after processing two-component character. Two-component recession clearly observed for 2–3 hours, indicating that the appearance of the water phases with on the other molecular mobility that exists in a limited time. During the time of relaxation this nonequilibrium state, a water and has an anomalous solubility and in this period it is asymptotically returns to equilibrium. From this water is created so dense the hydration shells, which are capable of increasing thermoresistance of proteins (Shestakov S., 2010; Krasulya O., 2012).

Homogenization of milk (the dispersion of large fat globules) by the cavitation effect is due to selectivity. Particles of the fat of different sizes is destroyed by pulses of pressure is not equally, that in the first place leads to the destruction of largest. In the dispersion process with increasing the surface of separation media there is a deficiency of substances that stabilize the emulsion of milk: proteins, di- and monoglycerides of fatty acids. If proteins can be moving to the surface of fat from the colloidal water phase of milk, a little breaking the equilibrium of the entire system, but the di- and monoglycerides in a balanced dispersed system of milk is take nowhere.

Found that on the frequencies of industrial emitters ultrasound cavitation threshold, above which there is a hydrolysis of milk fat, is overcome with the amplitude of the sound pressure is about 3 times higher than the hydrostatic pressure (Shestakov S., 2007). But together with hydrolysis formed and fatty acid residues (acyl) what increases the acidity and reduce the stability of the resulting mixture. In this work, studies were carried out milk mixtures, synthesized in the cavitation reactor in the absence of hydrolysis of fat. Processing is performed in the mode of hydrolysis of fat (control) and in the mode only disintegrations of structure protein of skimmed milk powder (experience). Relative stability to sedimentation of the samples was measured by the photometric method. For this, the specimens of each of the samples taken from the top and bottom of the beaker after assertion were measured values of the optical transmittance in the green region of the spectrum and calculated their ratio. It was found that at mixtures prepared in the mode of hydrolysis of fat, the optical density is generally higher because they have received is higher dispersion. But a bundle of samples prepared without hydrolysis less because at they excluded the effect on the stability of increased acidity.

Used for homogenization, including milk, ultrasound device by patent CA 2111802 (1992). In him is impossible to control the ratio of the hydrostatic and the average sound pressure, as the gap in which the process takes place, is a small. But because of it the energy cost of creating cavitation should be great. Homogenization of milk in (Glaznev N. et al., 2000) includes processing it through recirculation at temperatures up to +85 °C with respect to the acoustic transducer for forming cavitation. But heating the milk is the drawback of this homogenization, because, although the threshold of cavitation in liquids decreases with increasing temperature, but it is accompanied by a reduction of energy same of cavitation (Knapp R., 1970). This reduces the formation in milk dual solubility substances which stabilize the emulsion of milk. A rotor-pulsating device used for homogenization also (Volkov G., 2002). In such a device as a result of the pressure gradients in the milk of cavitation occurs, which destroys fat phase and makes a uniform particles size of milk fat. By increasing the surface area of the oil phase in the process of homogenization on the surface of the particles fat there a deficiency of substances for stabilizing the emulsion of milk. This can later lead to the inverse process - the coalescence of fat. Hence, the resulting milk formula will not be stable. To increase the stability of the emulsion of milk on the border between the lipid phase and the aqueous medium, which is increases during homogenization, sometimes artificially create the separation shell from proteins (Shestakov S., 2007). For this purpose before the acoustic cavitation to milk added proteins in amounts proportional to the expected increase in the specific surface of the fat phase. So the mixture is obtained which has a higher protein content. However, the protein itself is not prepared for hydration, because for the disintegration of its structure more mportant component of the energy of cavitation serves kinetic energy. For acoustic cavitation the ratio of energies has the advantage in favor of the potential component (Shestakov S. and Babak V., 2012).

In most of the known methods of hydration of biopolymers through preliminary processing of water by cavitation the number of energy does not explicitly set. For example, in (Shestakov S., 2008), where the water or an aqueous solution before being mixed with the biomass is treated with cavitation, given only the lower limit of the intensity of ultrasound divided by the square of hydrostatic pressure, what defines only the required power. The time activity of cavitation, i.e. the amount of energy for sonochemical changes in water remains arbitrary value. In patent application WO 2007111524 (2006) cavitation is cause by radiation of ultrasound with amplitude of sound pressure 5.5 values of static pressure in the cavitation reactor. Energy necessary to destroy the structure of water is given here through productivity of reactor and his electrical capacity. But the duration of the cavitation treatment of water

here is established by examining the dependence of the dynamic viscosity the water from the time of activity of the cavitation. It was assumed that the viscosity of water is determined by the ratio of volumes of its structured and unstructured components of water and obeys the law Einstein-Smoluchowsky (Rogov I. and Shestakov S., 2004). However, studies carried out in the University of Leiden (Jinesh K.B. and Frenken J.W.M., 2008), suggest that value of process performance is based on this hypothesis is understated. In practice, this can lead to excessive energy consumption.

Generally the epithermal energy transfer makes processes sonochemistry an order of magnitude more economical than thermal. Can compare, for example, the pasteurization, when the whole mass of the liquid containing the bacteria, is heated to a temperature of +70 ° C and above, which is held certain time and then sometimes and forcibly cooled, with a cavitational bacteriolysis, where for a mechanical destruction shells of microbes is requires only several periods of ultrasonic wave.

3. Disclosure hypothesis

Before the authors of the task was to find a way to obtain homogeneous, stable milk mixture with high-protein but without excessive costs on it of acoustic energy.

Known that cavitation with a certain level of potential energy displays water on some time out from the thermodynamic equilibrium. The water on the relaxation time of the nonequilibrium state acquires abnormally high hydration ability with respect to proteins (Shestakov S., 2012). Dense hydration shells which formed on the containing sulfur active groups of aminoacids of the protein are hinder it from thermal denaturation (Krasulya O., 2012). Therefore, if hydrate shell formed on molecular groups of milk protein, which include sulfur, they not allow □-casein blocking of □-lactoglobulin during further thermal exposure during pasteurization mix that will improve rennet coagulability of mixtures.

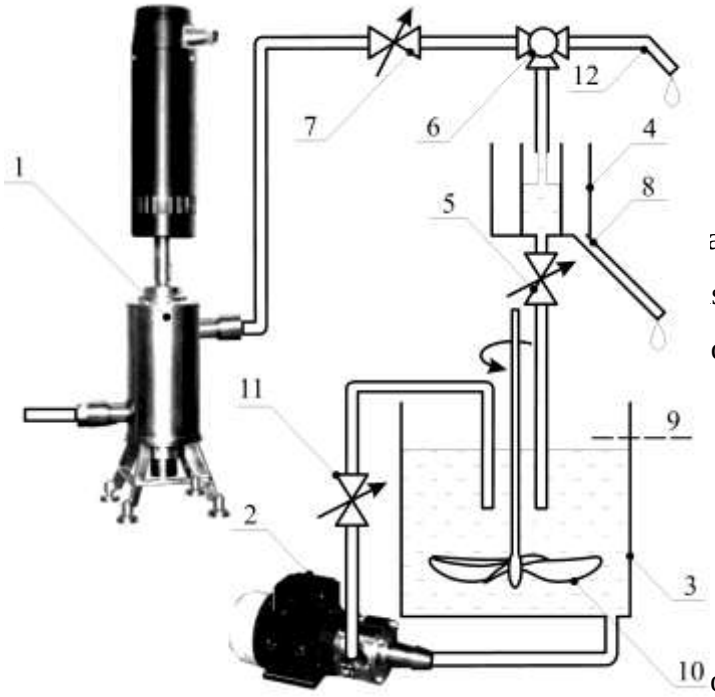
In addition, to recovery of milk powder better use water with small temporary hardness. Cavitation allows you to easily translate soluble bicarbonates into insoluble carbonate form, effectively reducing the temporary hardness of water. Mechanism of reaction is based on the destruction by pulses pressure from cavitation hydration shells dissolved and existing as ions bicarbonates Ca $(HCO_3)_2$ and $Mg(HCO_3)_2$. That is, it is based on the very same phenomenon, which destroys the supramolecular structure of the water, and promotes the transition of these hardness salts into amorphous colloidal form $CaCO_3$ and $MgCO_3$ (Tikhomirova N., 2011 a).

Under natural conditions in the milk the proteins form a supramolecular structure due to the dipole-dipole interactions between the molecules of aminoacids. This structure can be destroyed by hydrodynamic cavitation rotary-pulsational apparatus. So the aminoacids may be is prepared to join in hydration reaction. The polar centers of aminoacid more active than with molecular associates of water interact with dipoles, which are individual water molecules. But for that the water itself which is also has even at high temperatures own structure, to be unstructured. It is known that the best way to destroy the structure of water, that is, preparation for hydration - sonochemical processing of its in cavitation reactor (Shestakov S., 2012). Therefore, in order to obtain a positive result, it is sufficient to connect the inlet of mixer dry milk components and water to outlet reactor for water processing. Since the anomalous properties of water is saved did not last long, then at continuous preparing a mixture in apparatus, which is contain a reactor, there is need to harmonize the processing speed of the whole mixture in a rotor-pulsating device with sonochemical processing of water in that reactor. The latter should have the performance depending on the energy used. But, that determine this value necessary to know the specific (per unit volume) energy sonochemical treatment.

In monograph (Shestakov S.D., 2001) shows a fact of availability the maximum of the function of output of hydrogen peroxide at sonolysis of water, which is explained by the scattering of the acoustic energy on the internal friction in the water to form a heat, which weakens the cavitation. Consequently, the function of disintegration of the structure of the water from the spent energy must also have a maximum. Therefore, the range of energy sonochemical processing can be found through practical optimization. This range will be common to all the reactors in accordance with the principle of similarity of cavitation processes (Shestakov S. and Babak V., 2012). It is clear that have in mind the acoustic energy, because there are some ways to convert electrical energy into the energy of elastic vibrations with different coefficients of performance. In the device from patent application WO 2007111524 (2006) is used a way to convert due to the inverse piezoelectric effect. Efficiency it is 90%, and the specific performance of the device 0,6 m^3/h:(4 kW·0,9) = 0,17 $m^3/KW{\cdot}h$ Reactor which Is used here in practical optimize with power capacity of 630 watts is powered by a magnetostrictive transducer (efficiency 50%), has a productivity of about 2 dm^3/min.

4. Experimental confirmation of the hypothesis

Optimization was carried out using of that reactor in recirculation mode on the stand (Fig. 1), consisting of the dispersant 2, in as was which used a laboratory pump-emulsifier, mixer 3, filled before each experiment of whole milk by three quarters. The feed rate of water into the mixer is always maintained constant. For this used stabilizer 4, consisting of a coaxially placed one inside the other tanks and choke 5 which was coaxially mounted on the pipe coming out of them and adjusted on the minimum flow rate in the experiment. Skimmed milk powder is introduced, just sprinkling it in the mixer 3. Into the internal tank of the stabilizer from the outlet of the reactor through a three-way valve 6 is continuously fed water after sonochemical process. Performance adjusted through the setting on the output of the reactor the choke 7 and measuring cup. Thus, the reactor can run at any given performance, but the water from the stabilizer into the mixer is always fed at the same rate. Excess water at the filling of the tank flows through the drain pipe 8 which mounted on the bottom of the outer container. In the mixer, which is being filled during each experiment to the mark 9 for effective the mechanical agitation was set impeller of agitator 10. That is, mixing container had the appearance tank for pasteurizing or fermenting which used in dairy industry.



as carried out of the practical optimize spersant; 3 - mixer; 4 - stabilizer; 5 - ction, 9 - a mark, 10 - impeller mixer,

on through dispersant mixture with a given of throttle 11 speed. The experiment was conducted at room temperature. Five samples of mixtures were prepared with different productivities of the reactor. To do, when the reactor was off and the three-way valve 6 was switched to the discharge of water through the drain pipe 12, to establish the desired performance was used measuring cup. The mixers perfuse whole milk and add accordance in it with the patent application WO 2007111524 (2006)

skimmed milk powder, include the impeller of mixer, the dispersant and through 5 seconds switched the three-way valve on the supply of processed water to the stabilizer. By filling out the mixer to the mark 9 three-way valve 6 is switched to for discharge of water through the drain pipe, i.e. stopped supply to the reactor, turn off reactor, and continue mixing and dispersing for another 20 minutes.

The viscosity was measured by rotational viscometer in the volumes taken from the central parts of the tanks for storage of samples after settling for three days at a temperature +8 °C. The results of these measurements were divided by the viscosity of whole milk with the same number of the skimmed milk powder and the water, but without sonochemical processing. The received discretes regularities of the relative viscosity on the speed of processing were approximated by second-order polynomial the method of least squares. The point corresponding to performance 0.12 m^3/h lying on the branch of a parabola on the other side from maximum correspond abscissa 0.3 m^3/h. Inside thus obtained the range of viscosity of milk and, consequently, the dispersion of his fat phase, more than at in patent application WO 2007111524 (2006). It corresponds to diapason of specific energies of water processing 5...9 MJ/m^3, which should be shared for cavitation processes and at higher amplitudes of sound pressure (Shestakov S., 2001, 2012).

5. Findings. The practical implementation of research in industry

Results of this study on an industrial scale can be implemented (Fig. 2) by use as a dispersant rotary-pulsational disintegrator (Fig. 3), developed in the homeland of one of the first researchers the mechanical disintegration in rotary apparatus of Dr. J. Hint (Ashokkumar M., 2012) as well as the sonochemical reactor For example, an industrial processor UIP4000 company Hielscher Systems GmbH (Zisu B., 2010).

Fig. 2. Industrial version of implementation: 1 - rotary dispersant; 2 - sonochemical reactor with generator 3; 4 - mixing tank; 5 - circulation pump; 6 - metering pump; 7 - a device for the introduction of dry skim milk; 8 - water inlet.

This requires uploads dried whole or skim milk or whey powder or dry milk protein concentrate According to patent application WO 2007111524 (2006). If the protein may link at hydration to 40% water by weight (Kuntz I.D., 1975), need to add on this mass dry milk protein a monomolecular water. It is one third of volume of water which was subjected processing by cavitation (Rogov I. and Shestakov S., 2004). The protein that makes up a structural-mechanical boundary layer on the fat phase, thus will be more hydrated, therefore, will have a greater wettability and surface activity. As the mixing container to make a mixture, can use the ware production of MGT. Rotary disintegrator can include in the recirculation scheme the mixture through this container MGT, include in it a pump SIMPLEX-MS or STAMP-STN and device to boot the skimmed milk powder. From the reactor treated water can be fed directly into the container. For dosing of the water and the setting of the required capacity of the reactor can be used a dosing pump, for example, Pedrollo.

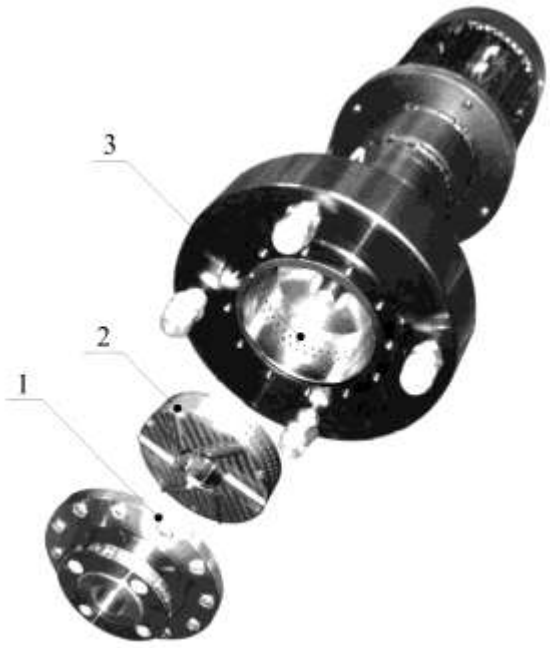


Fig. 3. The dispersant of company *Oil Tech Production OY* with removed lid of working volume 1 and removed rotor 2 from the stator 3.

References:

Ashokkumar M. at al. (2010) The ultrasonic processing of dairy products. *Dairy Science and Technology*, V.90, pp. 147-168

Ashokkumar M. at al. (2012) A New Look at Cavitation and the Applications of Its Liquid-Phase Effects in the Processing of Food and Fuel. *Applied Physics Research*, V4, 1, pp. 19-29

Glaznev N. et al. (2000) Patent RU 2172107

Jinesh K.B., Frenken J.W.M. (2008) Experimental evidence for ice formation at room temperature. *Physical Review Letters*, 101, 036101

Knapp R., Daily J., Hammitt F. (1970) *Cavitation*. New York: McGraw Book Company

Krasulya O. at al. (2012) Patent RU 2444201

Kuntz I.D. (1975) *The physical properties of water bound to biomacromolecules.* Water relations of foods / Ed. by R.B. Duckworth, London: Academic Press

Rogov I., Shestakov S. (2004). Epithermal change the thermodynamic equilibrium of water and aqueous solutions: Delusion and Reality. *Storage and Processing of Farm Products*, 10, pp. 9-13

Shestakov S.D. (2001) *Basics of cavitational disintegration*. Moscow: EVA press (in Russian)

Shestakov S. (2007) Technologies of cavitational disintegration in dairy industry. *Dairy industry*, 9, pp. 58-60

Shestakov S. (2008) Patent RU 2331478

Shestakov S., Krasulya O. (2010) Sonochemical technologies in food industry. *Electronic Journal "Technical Acoustics"*, http://www.ejta.org, 2010, 10

Shestakov S. (2012) *Food sonochemistry: concept, theoretical aspects and practical applications*. Saarbrücken: LAMBERT Academic Publishing

Shestakov S., Babak V. (2012) Mathematical Model of the Spatial Distributing of Density of Erosive Power of Multibubble Cavitation. *Applied Physics Research*, Vol. 4, No. 1, pp. 64-77

Tikhomirova N. at al. (2011) a Patent RU 2422371

Tikhomirova N. at al. (2011) b Ultrasonic sonochemical water processing. *Dairy industry*, 5, pp. 39-42

Volkov G. et al. (2002) Patent RU 2222952

Zisu B. et al. (2010) Ultrasonic processing of dairy systems in large scale reactors. *Ultrasonics Sonochemistry*, 17, pp. 1075-1081

THE EVOLUTION OF ELECTRONIC PUBLISHING: A LITERATURE REVIEW

M.T. Bashorun,

Priti Jain,

P.M. Sebina

T .Kalusopa

University of Botswana, Gaborone, Botswana Department of Library and Information Studies

Corresponding Author: M.T.Bashorun. (PhD Candidate)

Abstract:

Information Technology has changed the way information is processed, stored and disseminated. The prime aim of publishing is to disseminate new research findings as widely as possible in a timely and efficient manner. The ultimate goal of EP is to provide fast and easy access to information contained in the publications with simple, powerful search and retrieval capabilities. This paper presents literature reviews of EP, traces its developments and explores the components of EP with the benefits. It examines the rationale for copyright in digital age and trace development of EP in Africa with the challenges. The paper concludes that the future of EP in Africa is brighter with the great potential to flourish.

Keywords: Africa, copyright, electronic publishing, publishing, scholarly communication

1.0 Introduction

Information Technology has brought about changes from traditional print to electronic format. Electronic publishing (EP), uses new technology to deliver books and other content to readers. Since the technology allows publishers to get information to the readers quickly and sufficiently, it is causing major changes to the publishing industry and stakeholders in the publishing sector. The application of electronic technology to almost every aspect of human endeavours is on the increase in the modern era of digital information revolution (Oladejo and Adelua, 2012). For instance, the EP which is a relatively new channel for scholarly resources has radically changed global availability of scholarly publications. At the moment,

readers are no longer confined to print publications but can search, obtain and download scholarly papers from electronic journals, electronic books, and electronic archives.

There are several trends in EP of scholarly materials that are changing the face of information dissemination within the specialist research and professional areas. It is highly required to bring these innovations together and anticipate the next developmental stage of EP. A number of electronic publishing developments have some relevance to our ability to understand the current position of EP in Africa. Hence, this paper presents an overview of the evolution of electronic publishing, from 19th century of the scholarly journals up to 21st century.

2.0 Background

The combinations of computers and telecommunication technology have brought widely exposure to EP in the scholarly environment. EP has a vital role to play in developments of research in every sector, but we need to examine its various definitions.

What is electronic publishing?

EP could be defined as "the application by publishers of a computer aided process by which they find, capture, shape, store and update information content in order to disseminate it to a chosen audience"(Kist,1989, p.602). Ludwick (2000) describes electronic publishing as non-print materials produced digitally. EP in its broadest sense is the use of electronic devices in all aspects of production, management and distribution of primary and secondary information.

Cuadra (1981) identified two major tools that will facilitate electronic publishing as computers and communication network. Computers facilitate the production process, while distribution is handled through the communication networks, enabling the users to access data produced electronically. It can be concluded that electronic publishing is the process of production, dissemination, storage and retrieval of information in an online environment.

EP can be described considering its functionality as digital divide that brings innovative ways of bridging the global digital divide gap and creating social and economic benefits to the stakeholders, who were marginalized from access to research findings. There are various efforts made by many authors to discuss the developments in EP but technology developments in general are not stable.

The field of Information Technologies is currently witnessing an unprecedented phenomenon of globalization and acceleration due to the success of the World-Wide Web.

The process of publishing and distribution of information has been transformed by ICTs. In view of growth of information, electronic publishing has become a foundation for the new information society to get the right information to the right person at the right time. Therefore, it is necessary to address these questions; what is the current state of electronic publishing? What are its benefits and shortcomings compared to print publication? Is it destined to fail or are there indeed hidden assets waiting to be discovered by major stakeholders? What does the future hold in stock?

3.0 Objective

The main objective of this paper is to explore the current state of electronic publishing in Africa. The specific objectives are to:

- Trace development in electronic publishing
- Describe the processes involved in electronic publishing and traditional print
- Discuss the benefits and key issues of EP
- Examine the rationale for copyright in digital age.
- Trace electronic publishing development in Africa

4.0 Methodology

This is a desktop research and literatures were reviewed using core keywords for the literature search. To ensure that all concepts were included within publishing, the following general related terms, were used as core keywords for all literature searches 'publishing' combined with any of the following terms; digital, web, Internet and electronic. For example electronic publishing, web publishing, digital publishing etc. The literature searches were conducted using online databases (Library and Information Science Abstracts (LISA), Science direct, Ebscohost, Emerald, Africa Journals Online, Google scholar) available at University Library to retrieve journal articles in electronic publishing. LISA provides access to abstracts. The abstract accessed help to identify relevant articles; therefore an insightful analysis is possible. LISA offers authority controls strictly for subject terminology that can enhance recall or precision in searching. The searches were limited to publications in English. In addition, a variety of search engines (altavista, yahoo etc) were used to identify relevant works on electronic publishing. Different relevant materials like articles, books and c onferences proceedings addressing electronic publishing were used. Journal articles were consulted because they offer a relatively concise and up-to-date format for research.

Conference proceedings were used because they provide the latest research, or research that has not been published.

5.0 History of electronic publishing

The publishing revolution started five hundred years ago by Johannes Gutenberg with the printing press. The printing had gone into the next century, the World Wide Web (WWW) and Internet are without doubt introducing a new era in which the same kind of impact, if not greater, would be seen in the way we store, promote and distribute (or transmit) information. With the increasing popularity of the Internet, many developments have sprung up that enhance publishing (Ling *et al*., 1996). This trend needs to be traced for keeping abreast of development in publishing.

Evolution of electronic publishing can be traced back to 1970s when computers were first used to assist printing of abstracting and indexing services. It has since evolved along the technological growth for over four decades. The databases emerged online first in the late 1960s and Dialog became the first commercial online service in 1972 (Lancaster, 1995). By 1975, there were 300 publicly available online databases. Creation and remote accessibility of online bibliographic databases are considered as very important landmark in electronic publishing. Sophisticated online databases were built during the 1970s and the 1980s using high technology. The distribution of database management system link different remote systems using data files generated in the process of electronic photo typesetting of printed abstracting and indexing services and other primary journals (Arora, 2001).

With the recent advent of digital information systems and the Internet, the scope of publishing has expanded from traditional to electronic publishing. From 1970s, there was an interest in the use of electronic publishing not only because the traditional role of the scholarly publication. This role of reporting results quickly and as a formal record of peer reviewed scholarly achievement was under stress in the print world, because the two functions could be achieved better in the electronic environment (Oppenheim, 2008). The first electronic publication came in the 1980s in the form of plain text e-mails. They were sent to the subscriber via a mailing list (Chitra, 2010). The period between 1985 and 1995 referred to as a period of digital revolution, involved a marked shift from analog to digital treatment of information. The electronic distribution path was neglected as soon as new tools became available in the late 1980s and early 1990s. Later CD-ROMs appeared to be more effective medium for electronic publishing. This kind of publication was relatively successful

for a number of years and, for particular publications (encyclopedias, dictionaries, atlases, handbooks), are still in use (Pettenati, 2001).

The CD-ROM has a high reliability allowing the use of many different formats. It has excellent quality, pictures, figures, and long life at low cost support. However, CD-ROMs soon became unmanageable for libraries when each CD-ROM required the installation of a special client (software to read the CD-ROM) for each publication. In the 1990s, scholars realized that, the use of the world wide web would "accelerate research, enrich education, share the learning of the rich with the poor and the poor with the rich, make this literature as useful as it can be, and lay the foundation for uniting humanity in a common intellectual conversation and quest for knowledge" (Willinsky, 2002).

Then, in the years 1994–95 appeared the very first electronic journals (e-journal). The first e-journal to be distributed was Electronics Letters Online by IEE (Institution of Electrical Engineers). IEE distributed the journal via the Online Computer Library Center (*OCLC*)**;** OCLC invented a client, called Guidon, to be installed on the reader's station. Guidon was an excellent tool, with a very rich functionality but unfortunately, not Web-based (Pettenati, 2001). It became outdated as soon as the Web was chosen for the distribution of e-journals.

Web distribution started in 1995–96 and recorded immediate success. It was possible to use the rich format PDF (Portable Data Format), to embed links in the text and to start to use multimedia tools. Now, electronic publications are already prepared for downloading into Personal Digital Assistants (PDAs); it is a sort of e-book device already present in our pockets for other uses.

6.0 Electronic publishing: products and services

Electronic publication can be described as a document distributed primarily through electronic media in different forms. Electronic publishing is transforming itself in a wide range of products and services, although most of them try to be like the traditional publishing while others are revolutionary in their approach and design.

6.1 Electronic books

Borchers (1999) defines an eBook as a portable hardware and software system that can display large quantity of readable textual information to the user and let the user navigate through this information. An eBook is digital reading material that a user can view on a desktop or notebook personal computer, or on a dedicated, portable device with a large

storage capacity (1,500 to 50,000 pages) and the ability to download new titles via a network connection required hard ware. The reader hardware is expensive, e-titles cost about the same as their print counterparts, ink and paper are still easier to read and handle. Chong and Ling (2009) investigate the students' preference for the e-book designs. Researchers compiled three e-books non-fiction in portable document format for evaluation. It was indicated in the result that ease of use of e-book is highly associated with ease of navigation. Publishing a book electronically is to achieve greatly decreased publication costs, quick and dissemination of information (Cunningham and Rosebush, 1996). CD-ROM is appropriate medium for publishing books because it can be operated offline without Internet and it relieves end users of the fear of high connecting time charges, the readability of the *text* and preservation of the quality of the images (Koganuramath et al., 2000).

6.2 Electronic periodicals

Electronic journal (or e-journal) is defined as any journal, magazine, e-zine, webzine, newsletter or type of electronic serial publication which is available over the Internet and can be accessed using different technologies (Arora, 2001). Electronic Periodicals are accessible to all users regardless of geographic location. Anyone in the world with services and the proper computer software and browser services can access online journals. This accessibility leads to a more diverse audience throughout the world as well as a readership that may include not only academics, but students and lay people (Saxena, 2009).

6.3 Electronic databases

With the influx of computers and communication technologies, the strength of information system in the development of modern database has taken a new dimension. The stocks of the library database consisting of books, periodicals, reports and theses can be converted to electronic form that allows access for public use through digital networks. A variety of electronic database publishers today account for publishing information both bibliographic and full text on CD-ROMs as well as making them available for On-line retrieval. The prominent On-line publishers include DIALOG, EBSCO host etc (Chama and Saxena, 2008).

6.4 Electronic publishing on CD-ROM

CD-ROM has provided new dimension for information storage and retrieval. Publishing information mainly abstracting sources are quite common in CD-ROM. Although

much of the work on e-journals has concentrated on distribution via the Internet, there has been some work on CD-ROM as well. There are many non network electronic publications such as encyclopedias on CD and DVD as well as technical and reference publications relied on by mobile users without reliable and high speed access to a network (Kumar, 2012). Some of the advantages of CD-ROM are;

- More material can be included, both in terms of quantity (650+megabytes) and type (multi media resources).
- Full text searching is relatively easy to include.

6.5Print-on-Demand (POD)

Print-on-Demand is a new method for printing books (and other content) which allows books to be printed one at a time, or on demand. It is a mix of electronic and print publishing .i.e (print on demand combines the Internet with more traditional publishing methods). The book is held by the publisher in electronic form and is printed out in the hard copy form only on order. This method helps free publishers from the process of doing a traditional print run of several thousand books at a time. Print on demand thereby "eliminates the need for editions to be printed beforehand, greatly reducing up front publishing costs" (Segur-Cabanac, 2005).

POD is highly in demand nowadays, because it is a good intermediary step between the regular method of printing paper books and electronic books**.**

6.6 Digital content

Digital content generally refers to the electronic delivery of fiction that is shorter than book-length, nonfiction, and other written works of shorter length. Publishers of digital content deliver shorter sized works to the consumer via download to handheld and other wireless devices. Technology used for delivering digital content includes portable document file (PDF), hypertext markup language (XML), WAP (Wireless Application Protocol) and other technologies. The security of the data being delivered is the major concern of publishers, who want to ensure they can deliver digital content without the risk of someone copying the work and selling or giving away the works (Saxena, 2009).

6.7Electronic ink

Electronic Ink is a developing technology that has a huge impact on the media and publishing industries. Electronic Ink could be used to create a newspaper or book that updates itself. It is a high-contrast reflective display ideal for e-book applications. In addition, this content could be programmed to change at any time. For example, you could have a billboard that rotates different advertisements, or you could receive a coupon in the mail that is frequently updated with the latest offer. For media companies, the possibilities are almost endless. Someday, electronic newspaper will simply update itself every day. E - Ink Corporation, a new company with major investors, and Xerox are two companies currently developing this technology (Saxena, 2009).

6.8 Email publishing

Email publishing is designed specifically for delivering regular content-based email messages. Email publishing, or newsletter publishing is a popular choice among readers who enjoy the ease of receiving news items, articles and short newsletters in their email box. The ease of delivery and production of email newsletters have led to the development of a massive number of available email newsletters, mailing lists and discussion lists on a large variety of topics (Saxena, 2008).

6.9 Web publishing

Web publishing is not a novel practice any longer, but it continues to change and develop with the introduction of new programming languages. Hypertext Markup Language (HTML) is still the most widely used web programming language, but Extensible Markup Language (XML) is also making headway. XML is valuable because it allows publishers to create content and data that is portable to other devices. Nearly every company in the world has some types of website, and most media companies provide a large amount of web based content (Saxena, 2009).

7.0 Features of electronic publishing

The electronic publishing has several features, which makes it to be unique as outlined below:

- EP contents spread to researchers within the little time

- Ease of making correction if need arises, an electronic text can be updated or corrected with the same immediacy.
- Allows anyone with access to a networked computer to 'publish' on the internet.
- Provides high global visibility for the works
- Overcome geographical barriers associated with print media
- Distribution times between production, publication and its delivery have been drastically reduced as shown in figure 2.

8.0 Components of Electronic Publishing Process

The need to understand the key elements that are involved in electronic publishing process is essential, though similar with traditional publishing but this component does not fade away in the electronic era. The valid content, clarity of expression, and effectiveness of presentation increase as more of the journals are read on the screen. This allows comments and contributions from readers within the shortest period of time contrary to traditional publishing that associated with delay in peer review and editing processes. The elements of the publishing process are:

- Author preparation - to create intellectual content.
- Peer Review - to ensure scientific quality and appropriate scholarship.
- Copy editing and typography – for clarity and effectiveness of presentation.
- Database preparation-the core of electronic system, to ensure access and interoperability.
- Production and Distribution - to make literature available for use.
- Archiving to ensure continuing availability and authenticity and to maintain the historical record (Hartmann, 2011:2).

The components of electronic publishing process are illustrated in the figure (Figure 1).

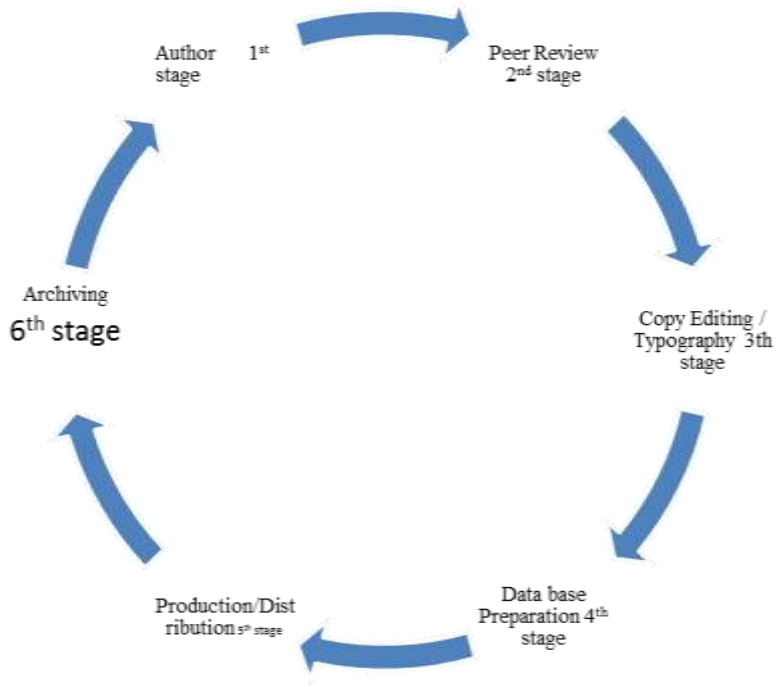


Figure1: Elements of Electronic publishing Process (Adapted from Hartmann, 2011)

9.0 Scientific communication through journals

Publishing articles within scholarly journals achieves several objectives: to communicate advances in knowledge, to register a researcher's priority of discovery, to submit findings to the critical examination of the researcher's peers, and, through the resulting imprimatur of experts, to achieve recognition for verified original findings, primarily through enhanced career prospects or further research grants (Fjallbrant, 1997). Scholarly publishing has achieved these objectives since the first publications were disseminated in the 17th century. According to Bacon's writings the progress in science is achieved by incremental accumulation, that it is "fertilized through sustained social interaction between scientists and attained through reasoned and systematic empirical methods of inquiry" (Merton, 1973, p.349). The printed journals were also a means of communication in an age where post was uncertain, carried by hand, carriage or ship between towns and different countries. Even when post available, the mails travel at "snail movement" (took longer period to reach the destination).

10.0 Electronic publishing as a tool for scholarly communication

Electronic Publishing (EP) has direct link with scholarly communication of the research outputs to the beneficiary. The author needs to publish the result of their research to

the public. This could be done by using EP or traditional form of publishing. Scholarly communication is a multifaceted and rigorous process involving many stakeholders. Scholarly communication refers to the clear research findings, formal as well as informal, which the academic and scientific community made known to the world for public consumption.

These findings are meticulously brought out research reports, called 'article' or 'paper', perhaps influenced by the medium used to print them. This has shown in the process of publishing, where delays in production occur. The usual delay experienced in traditional publishing has been removed in e-publishing, where knowledge production is delivered at minimal cost and time.

Arora (2001) carried out study on EP overview, he observed that revolution has just begun, and is going through a process of adaptation. Authors, publishers, users and librarians are only just beginning to take advantage of potentials of electronic media. He concludes that the ongoing shift towards EP is expected to continue.

This changing scenario in scholarly communication is possible as results of electronic publishing that were aided by Internet in an open access environment. Thus, electronic publishing has changed the scenarios in scholarly communication.

There are three basic models that exist in scholarly communication accepted by the stakeholders (authors, publishers, libraries and readers) as shown:

- The traditional paper based publishing process
- E-publishing on commercial basis and
- Open access model of publishing.

The recent developments in Information Technology (IT) and Internet have great impact on scholarly communication chain as illustrated in Figure 2. The traditional journals in paper format took 36-52 weeks to publish scholarly work but with EP, the total cycle time of 1 year, the value addition (generation, review, editing and printing) take place in 2-3 weeks (Sreekumar, *et al*., 2007). Aina and Mutula, (2006) observed that in EP, the process is much faster, easier: the period between receipts of manuscripts and editorial board's decision is now less than three months. This has greatly enhanced the production process of journal. It is obvious, that the advent of the EP has greatly boosted the scholarly publishing domain, reducing the publishing time frame to a remarkable 3-4 weeks.

The third category is the growing sets of open access publishing and scholarly archive initiatives, which are the outcomes of the Open Access movement, catching up worldwide. Authors are now publishing their works at fast speed such as 2-3 hours or even at a lesser time.

Communication between editor-in-chief and the authors, as well as editor and referee experienced delay. With the recent development in EP, the manuscripts sent to editor-in-chief electronically; peer review is done through e-mail, editor sends edited soft copy to the printer electronically. Thus, publishing process is faster.

The relative features and merits of the three systems are displayed in the figure (Figure.2)

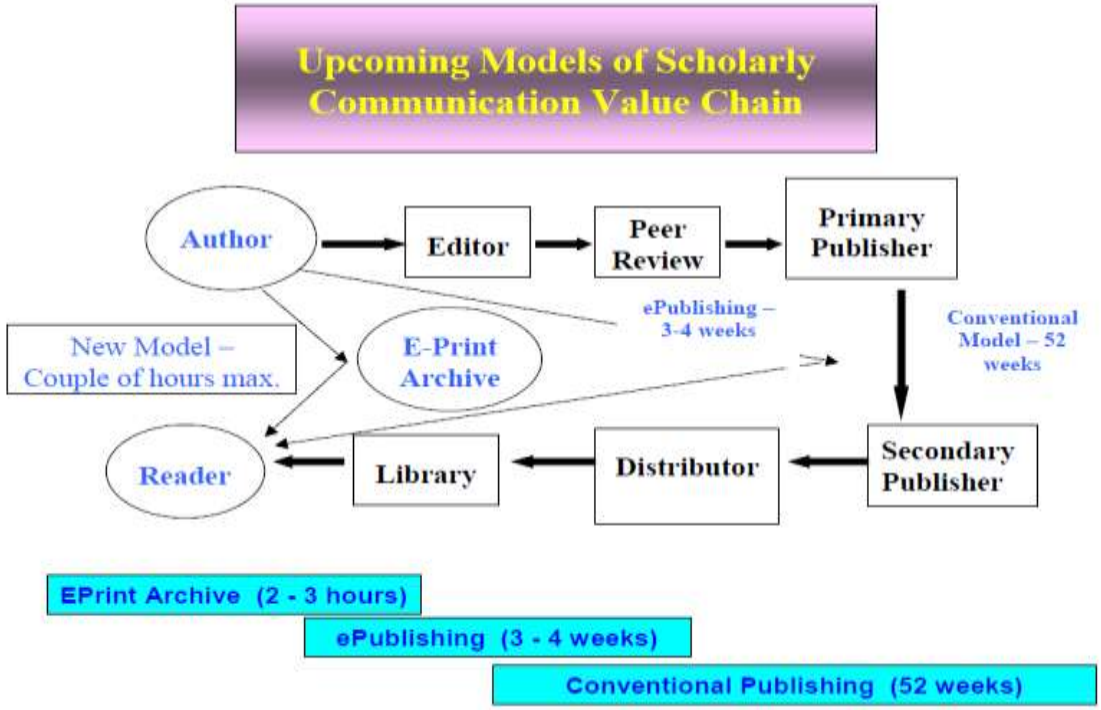


Figure 2: Scholarly Communication Value chain (M.G. Sreekumar et al, 2007)

EP gives greater freedom to researchers to disseminate their research results without having to go through the cumbersome route of finding a publisher who is willing to publish their research findings. Now, authors get their work published in electronic format or in electronic archive within 2-3hours against conventional publishing of 52 weeks.

With the advent of EP as shown in figure 2, it gives room for the authors and readers to shun publishers. EP has recorded land mark achievements and it will continue as long as ideas lead to new discoveries and new innovations in electronic publications are growing. This will enhance the enormous benefits of EP as discussed below.

11.0 Benefits of electronic publishing (EP)

Latamore (2011) carried out a study on advantages of electronic publishing over paper printing. He observed that one of the largest drains on corporate funds and productivity still be the endless reliance on paper documents. Thirty years after the PC revolution put computing power in the hands of virtually every employee, almost all documents are created electronically. Yet paper documents are everywhere in offices today, and executive are even known to print their e-mail.

In the current information technology era, researchers have greater expectations that EP will solve the problems like high cost and restrictive policies associated with traditional publishing (Ng, 2009). These have resulted in limited access to information, research output, innovation and exchange of ideas. However, the vital role of EP cannot be over emphasized considering the outweigh advantages, it has over print, as stated below;

- One of the most obvious advantages of e-books over traditional publishing is significantly lower production costs;
- Rapid publication since electronic speed the process of peer review, manuscripts can be immediately received attention with acceptance letter sent to author;
- Faster publishing time for accepted manuscripts. Rather than waiting up to two years for a manuscript to see print;
- Large citations can be searched and retrieved simultaneously and instantly;
- Innovative use of multimedia: to present research findings and other forms using sound, movies and simulation;
- Hypertext and hypermedia links: linking to other electronic information is possible at faster speed and
- EP facilitates open access (OA) principles (visibility and accessibility)

12.0 Key issues in electronic publishing

Despite the tremendous benefits accrued from electronic publishing, yet it has shortcomings as mentioned below;

- Quality of content: Another difficulty that needs to be overcome about content security. Publishers, looking at the Internet piracy problems, tampering with uploaded information.

- Different formats: There are many formats of electronic publications; this has constituted problems to users despite its advantages though it is unlikely that one digital file format will triumph over all the others.
- Increased opportunity for scientific misconduct: allows series of research misconducts like submission of same research results to more than one journal (Jennings and El-adaway, 2012).
- Copyright infringement; copyright is an issue that stakeholders bothered to tackle, especially in an online environment. Using authors work without appreciation or permission is very common in electronic publications, due to free access. Therefore, it is highly essential to discuss the concept of copyright for adequate awareness and benefits to the stakeholders.

13.0 Copyright in digital age

The legal issues related to EP and OA are complex. The universal nature of EP and OA creates the major legal problem. Each country in the world has its own legal system and practices that are acceptable or common in one country may be illegal in another. Authors/scholars, users, publishers, and advocate on all sides of issue have a variety of opinions about who owns work in the electronic world. Copyright issues are vital to knowledge production, distribution and dissemination (Business dictionary, 2012). Historically copyright has served as the fundamental intellectual property protection for authors and publishers. At present, there is intense public discussion on how to realize intellectual property rights by giving them a legal frame in the digital age (Samuelson, 2000).

Copyright can be described as a Legal monopoly that protects published or unpublished original work (for the duration of its author's life plus 50 years) from unauthorized duplication without due credit and compensation (Business dictionary, 2012). Prytherch (2000) defines Copyright "as a procedure whereby the originator of a recorded work acquire a series of right over the work created, including copyright, publishing, performing, broadcasting and adaptation for determined period of time" (p.1). Copyright covers not only books but also advertisements, articles, graphic designs, labels, letters (including emails), lyrics, maps, musical compositions, product designs, etc. According to the major international intellectual-property protection treaties (Berne Convention, Universal Copyright Convention, and WIPO Copyright Treaty (1996), five rights are associated with a copyright: the right to: (1) reproduce the work in any form, language, or

medium. (2) Adapt or derive more works from it. (3) Make and distribute its copies. (4) Perform it in public. (5) Display or exhibit it in public (Drahos, 1999). To acquire a valid copyright, a work must have originality and some degree of creativity. However, what is protected under copyright is the 'expression' or 'embodiment' of an idea, and not the idea itself. A copyright is not equivalent of legal-prohibition of plagiarism (which is an unethical and unprofessional conduct, but not an offense), and does not apply to factual information (Business dictionary, 2012).

13.1 Rationale for copyright law and fair dealing exemption

The first copyright law (the Statute of Anne) was promulgated in 1710 in England. The objective of the act was to encourage 'learned men to compose and write useful work' (Leaffer, 1989). The concept of the fair dealing exemption emerged from early century British case law (McDonald, 1999) and this was evolved from the specific technological and social situations of the time. There were legal issues that brought the concept 'fair dealing' a case of Cary v.Kearsley made the Lord Ellenborough asked whether the work that was centre of dispute was 'used fairly' (Patry,1995).

In 1839, there was an express use of the term 'fair use' in its current combination in a case of Lewis v. Fullarton (Masango, 2009). The rationale for countries referring to the exemption as 'fair dealing' may be because although fair use is more broader than fair dealing, the latter is more detail than the former (Rimmer, 2004). Countries in their copyright acts expressly provide a clause of either 'fair dealing' or 'fair use' exemption in their copyright acts. The copyright fair dealing exemption allows individuals to copy portion of works for certain purposes such as research, criticism, teaching, and under certain circumstances that will not interfere with the legitimate rights of copyright holders (Amen, Keogh & Wolff, 2002).

The function of exemption is to balance the right of publishers and users of copyrighted works. The fair use exemption allows copying of printed copyrighted works and its content was changed as new reprographic technologies emerged, nations such as the United State in its Digital Millennium Copyright Act (DMC) 1998, and Australia in the Copyright Amendment (Digital Agenda) Act 2000. Copyright owners have pointed out that the relative ease that technology gives to users to make copies, cut and paste, etc has effect of jeopardizing the owner' economic interests and gains. Protection of digital work has been facilitated by the use of DRM technologies. DRM could be defined as "a collective name for

technologies that prevent you from using a copyrighted digital work beyond the degree to which copyright owner wishes to allow you to use it" (Litman, 2001).

DRM technology can help publishers provide online licensing, track use, control unauthorized use, protect copyrighted content, ensure integrity, and enforce ownership. According to Richman et al (2002), DRM has two components: encryption and decryption, the keys that lock and unlock information. In more complex systems of encryption and decryption, different keys are needed for each process. Encryption is the process by which information is scrambled to make it unusable to non-authorised users. One particular system of encryption that is vital to DRM systems is the so-called 'Public Private-key´. Despite the issues affecting EP, it facilitates fast access and wide spread of research output. According to Tonta and Duzyol (2010), the study to chart the evolution of e-publishing as a research field using Cite Space and keywords was visualized through a number of co-citation maps. It was indicated that "open access" would improve our understanding of the e-publishing as a research field.

14.0 Electronic publishing development in Africa

The digital revolution that has affected the entire world also has influenced on Africa. Many efforts have been put in place in Africa that enhanced scholarly work and ensured free access of research outputs. Thus, African countries in their struggle not to fall behind join the waves of changes, as affirmed with following initiatives towards electronic developments in Africa.

The African journals Online (AJOL), is an initiative of the International Network for the Availability of Scientific Publications (INASP), in partnership with publishers in Africa. It was based in UK but now moved to South Africa. It aims is to assist African journals to publish online and offer electronic delivery in order to increase journal use and sustainability It offer access via internet to tables of contents (TOC) and abstracts of Africa published journals in agriculture, social sciences, humanities, health and sciences and technology. As at September, 2012, over 437 journals published in 26 countries in Africa including Francophone. Most of the journals published were from Nigeria and South Africa, these two countries alone account for 62 per cent.

There are few initiatives to assist Africa journals to publish online. These include INASP's programme to support journals on the AJOL database by assisting them to publish on commercial host. South Africa's Bibliographic Network (SABINET) provides electronic access to over 200 journals published in South Africa. Bioline International is another

enterprise that facilitates certain Africa e-journal online on the web. It is a collaborative initiative of the University of Toronto Libraries, Canada, the reference Centre on Environmental Information (Brazil) and Bioline UK.

International institutions and many organizations gave adequate backing to discussions, conferences, meetings and workshops about the creation, access and use of electronic publishing in developing countries with special consideration for Africa countries. In October, 1998, a workshop was organised at Paris, sponsored by the International Council for Science (ICS) and UNESCO, under the auspices of AAAS (American Association for the Advancement of Science). The main goal was to examine the application of the electronic method for publishing scientific journals, in order to stimulate the development and international recognition of Africa research projects.

Other experiences with positive development in Africa were that of the Electronic Jou rnals Publishing (EJP), supported by the Electronic Publishing Trust (EPT) which has a goal to stimulate African publishers to acquire abilities needed to start up electronic publishing, together with providing them with access to international support, by means of partnership with other publishers. The INASP (International Network for Availability of Scientific Publications), through the PERI (Programme for the Enhancement of Research Information) programme, the goal was to help and encourage researchers in the preparation of text to be published in electronic formats. There are other ongoing initiatives and projects in which Africa electronic publishing may be found e.g AJOPP (African Online Publishing Project). The project put publications online. Despite all these projects, Africa publishers are still required to be more active and make efforts to disseminate their publications by electronic means, assuring them wide visibility. These initiatives are easier to be describing than put into action, on account of several obstacles as discussed below.

15.0 Challenges of Electronic Publishing in Africa

The digital revolution brought changes with challenges that affected the entire Africa and Africans have started to ponder extensively about the development. Challenges facing Africa are enormous with boundless possibilities of the new technology, which divide them into two groups: those who are in support of the adoption of these technologies and those who do not trust them. The role of these electronic publications in developing countries may be different from their role in developed nations. Aparicio (2009) carried out study on access to the electronic publishing in Africa countries. She observed that acceptance, rejection or

involvement in electronic publishing in African countries may be influenced by the way entire process is treated by the context.

Obstacles and difficulties experienced in Africa as the matter of access to electronic services are ;

- lack of adequate supply of electricity;
- language barrier;
- lack of qualified manpower;
- low internet;
- poorly developed publishing infrastructure;
- lack of sustainable funding and
- Poor and high telecommunication access charges constrain

16.0 Conclusion

The revolution has just begun and it is undergoing adaptation. Electronic publishing (EP) has the potential of greatly increasing the spread of knowledge throughout the academic arena and by extension, the entire world (Jeffres & Lyle, 2012). With the access to basic ICTs and the Internet that are prerequisites in the development and use of EP. Stakeholders will take advantages of the potentials of electronic media. In addition, they will utilise enormous opportunities that thrive for the development in all human aspects of life. There are indications that research is being carried out in Africa. However, the visibility of these research outputs needs to be increased through EP. This growth of scholarly publishing in Africa depends on the production of freely access research findings from universities and other research institutions. This growth of EP will continue to record landmark achievements. It is hoped that, the enhancement of EP will close the digital divide gap between the developed and the developing countries (Arunachallam, 2002). It will continue to accelerate many evolutionary trends in scholarly communication. It is therefore; appropriate to submit that the future of EP in Africa is brighter with the great potential to flourish.

References:

Aina, L.O. & Mutula, S.M. (2006). Opportunities for electronic publishing in Africa. In: Alois Mlambo, (Ed.). African scholarly publishing essays, Oxford: African Books Centre, pp.193 - 200.

Amen, K., Keogh, T., & Wolff, N. (2002). Digital copyright: A tale of domestic discord, presented in three acts. *Computer in Libraries*, *22*(5), pp22–27.

Aparicio, M.A.M. (2009). Access to electronic publishing in African countries: some reflections. From information to knowledge*: Proceedings of the 7th ICCC/IFIP International Conference on Electronic Publishing*, Universidade do Minho, Portugal 25-28 June. Retrieved 11th June, 2012 from http://elpub.scix.net/data/works/att/0312.content.pdf

Arora,J. (2001). Electronic publishing: An overview. Joint workshop on digital libraries. Retrieved from:http://drtc.isibang.ac.in/xmlui/bitstream/handle/1849/129/Arora2.pdf?sequence=2

Arunachallam, S. (2002). Reaching the unreached: What role can ICTs play in rural development? Paper presented at the Asian Regional Conference of UNICT Task Force Media Lab Asia (New Delhi, 25 April).

Borchers, J. O. (1999). Electronic books: definition, genres, and interaction design patterns. ACMCHI Electronic book workshop. Retrieved 4th June, 2012 from *http://www.fxpal.com/chi99deb/*

Business Dictionary.com. (2012). What is copyright? Retrieved from: http://www.businessdictionary.com/definition/copyright.html

Chama, M. & Saxena, A. (2008). Impact of ICT in LIS: Electronic publishing. Retrieved 18thJune, 2012 from: http://ir.inflibnet.ac.in/dxml/bitstream/handle/1944/1253/19.pdf?...1

Chitra, S. (2010). Electronic publishing. Retrieved 12th June, 2012 from: http://dspace.iimk.ac.in/bitstream/2259/621/1/chitra.pdf

Chong P.F, Lim Y.P & Ling S.W. (2009).On the design preferences for Ebooks. *IETE Tech Rev.* Retrieved 9thAugust, 2012 from: http://tr.ietejournals.org/text.asp?2009/26/3/213/50706

Corrado, P. (2001). Electronic publishing at the end of 2001. Retrieved 6thJune, 2012 from: http://villaolmo.mib.infn.it/Manuscripts/10_generalities/pettenati.pdf

Cuadra, C.A, (1981). A brief introduction to electronic publishing', *Publishing Review*, 1(1), pp29-34.

Cunningham, S. & Rosebush, J. (1996), Electronic Publishing on CD-ROM. Sebastopol, CA: O'Reilly.

Digital Millenium Copyright Act. Retrieved 8th July, 2012 from: http://www.loc.gov/copyright/re ports/studies/*dmca/dmca_study.html*

Drahos, P. (1999). The universality of intellectual property rights: Origins and development. Retrieved 22nd July, 2012 from: www.wipo.int/tk/en/hr/paneldiscusson/papers/.../drahos.pdf

Fjallbrant, N. (1997). Scholarly communication: historical development and new possibilities.

Paper presented at the IATUL Conference, University Library of Trondheim.

Guedon, J. (2001). In oldenburg's long shadow: Librarians, research scientists, and the control of scientific publishing. Annapolis Junction, MD: ARL. Retrieved 5th August, 2012 from: http://www.arl.org/arl/ proceedings/138/guedon.html

Harter, S. P. & Kim, H. J. (1996). "Electronic journals and scholarly communication: a citation and reference study." *Proceedings of the Midyear Meeting of the American Society for Information Science*, San Diego, CA, pp299-315 Retrieved 16th June, 2012 from: http://php.indiana.edu/~harter/harter-asis96midyear.html.

Hartmann, C. (2011). *Increasing the quality and timeliness of scholarly peer review.* Retrieved 17th July, 2012 from*: scholarone.com/media/pdf/peerreviewwhitepaper.pdf*

Jeffres, L. & Lyles, S. (2012). Making publications public: Using electronic publishing technology to disseminate research to wider academic community. *The Orlando International Academic Conference*, Orlando, Florida, USA.

Jennings, M. & El-adaway, I. (2012). "Ethical issues in multiple-authored and mentor-supervised publications." *J. Prof. Issues Eng. Educ. Pract.*, 138(1), pp 37–47. Retrieved 6th July, 2012 from:http://ascelibrary.org/action/showAbstract?page=37&volume=138&issue=1&journa lCode=jpepe3

Kist, J. (1989). Electronic publishing. In Eraut, M. (Ed.). International encyclopedia of educational technology, New York: Pergamon. pp. 600-608.

Kling, R., & Callahan, E. (2003). Electronic journals, the Internet, and scholarly communicati on. *Annual Review of Information Science and Technology 38:* pp 127-177

Kogannurrnath, M..M., Jange, S. & Angadi, M. (2000). Electronic publishing: An analytical study. In Babu, T. A. (Ed.). vision of future Library and Information System. New Delhi: Viva Books Pvt. Ltd., pp. 209-1 5.

Kumar, S. (2012). Digital publishing or e-publishing process and use. Retrieved 6th October, 2012 from: http://www.articlesbase.com/publishing-articles/digital-publishing or-e-publishing-process-and-use-5839422.html

Lancaster, F. W. (1995). The evolution of electronic publishing. Retrieved 12th September 20 12, from:http://webcache.googleusercontent.com/search?q=cache:kkNbe95htBIJ:findar ticles. com/p/articles/mi_m1387/is_n4_v43/ai_17096178/+the+evolution+of+electronic+publishin &cd=3&hl=tn&ct=clnk&gl=bw&client=firefox-a

Latamore. B. (2011). The advantage of electronic publishing over paper print. Retrieved 8th September,2012 from:http://wikibon.org/wiki/v/The_Advantages_of_Electronic_Publishing over Paper Printing

Leaffer, M. (1989). Understanding copyright law. New York: Matthew Bender.

Ling, T. C., Yaacob. M. H & Phang, K.K. (1996). An overview of electronic publishing. *Malaysian Journal of Library & Information Science*, 1(2), pp 1-11.

Litman, J. (2001). Digital copyright. Amherst, prometheus books. pp. 35-63.

Ludwick, R., & Glazer, G. (Jan. 31, 2000): Electronic Publishing: The Movement From Print To Digital Publication *Online Journal of Issues in Nursing*. 5, (1), Manuscript 2.

Masango, C. A. (2009). Understanding copyright in support of scholarship: Some possible challenges to scholars and academic librarians in the digital environment. *International Journal of Information Management*, 29. pp 232-236

McDonald, I. (1999). Copyright in the new communication: Balancing protection and access Retrieved 20th August, 2012 from: http://www.copyright.com.au/reports%20&%2 0papers/new% 20communications%20environment.pdf

Ng, K. H. (2009). Exploring new frontiers of electronic publishing in biomedical science. Retrieved 12th July, 2012 from: http://smj.sma.org.sg/5003/5003des1.pdf

Okerson, A. (1992), "Publishing through the network: the 1990 debutante", Scholarly Publishing, 23(3), pp170 -177. Retrieved 15th June, 2012 from: www.ariadne. ac.uk/issue21/pubmed/intro.html

Oladejo, M.A. & Adelua, O.O. (2012). Motivational predictors of academics' electronic publishing in Nigeria colleges of education. *European Journal of Globalization and Development Research.* 4 (1), pp.195-209.

Oppenheim, C. (2008). Electronic scholarly publishing and open access. *Journal of Information Science*, 34(4), pp577 – 590.doi:10.1177/0165551508092268

Patry,W. F. (1995). The fair use privilege in copyright law (2nd ed.).Washington, D.C.: Bureau of National Affairs

Pettenati, C. (2001). Electronic publishing at the end of 2001. *World Scientific*. Retrieved 10th July, 2012 from: http://villaolmo.mib.infn.it/Manuscripts/10_generalities/pettenati.pdf

Prytherch, R.. (2000). Harrod's librarians' glossary and reference book (9th ed.). Aldershot: Gower

Richman, C, Czech, I & Risher, C.A, (2002). Copyright and permissions in the electronic age.

Retrieved 12th June, 2012from: http://www.councilscienceeditors.org/files/scienceeditor/v25n6p191.pdf

Rimmer, M. (2004). Canadian rhapsody: Copyright law and research libraries. *Australian Academic & Research Libraries*, 35(3), pp193–213. Retrieved from: http://alia.org.au/publishing/aarl/35.3/full.text/rimmer.html.

Samuelson, P. (2000). Digital dilemma: A perspective on intellectual property in the information age. Retrieved 5thJune, 2012 from: http://bthukuku.bilgi.edu.tr/documents/digital_dilemma.pdf

Saxena, A. (2009). Electronic publishing: Impact on academic libraries. Retrieved 16th July, 2012 from: http://crl.du.ac.in/ical09/papers/index_files/ical-_117_142_311_2_RV.pdf

Screekumar, M.G, Sunitha,T, Sreejay,P, Biju,R, Kuriakose,J & Kalathil, P.(2007). Institutional repositories for knowledge management in academic and research institutions, in ARD Prasad & Devika P.Madalli (Eds.), pp 260-273 Segur-Cabanac, M.N. (2005). Electronic publishing. Retrieved 7th July,2012 from: http://www.p- mi.com/wordpress/wpcontent/uploads/2006/08/Essay_Electronic_Publishing.pdf

Tonta,Y & Duzyol,G (2010). Mapping the structure and evolution of electronic publishing as a research field using co-citation analysis. Retrieved 20thJuly, 2012 from: http://yunus.hacettepe.edu.tr/~tonta/yayinlar/tonta_duzyol_ELPUB2010-helsinki-e-publishing.pdf

Willinsky, J. (2002).Copyright contradictions in scholarly publishing .Retrieved from: http://en.scientificcommons.org/8416231.

EFFECT OF PASSIVE AND ACTIVE RECOVERY ON THE RESYNTHESIS OF MUSCLE GLYCOGEN

Dr Adesola,

Adefemi Muritala

Department Of Physiology Faculty Of Basic Medical Sciences, Ladoke Akintola University Of Technology, P.M.B 4000, Ogbomoso, Oyo State, Nigeria

Abstract:

The purpose of this investigation was to determine the effect of passive and active recovery on the resynthesis of muscle glycogen after high intensity cycle ergometer exercise in untrained subjects. In a cross-over design, six college-aged males performed three, 1-minute exercise bouts at approximately 130% VO_2 max with a 4-minute rest period between each work bout. The exercise protocol for each trial was identical, while the recovery following exercise was either active (30 minutes at 40-50% VO_2 max, 30 minute seated rest) or passive (60 minute seated rest). Initial muscle glycogen values averaged 144.2 ± 3.8 $mmol.kg^{-1}$ w.w. for the active trial. Corresponding immediate post exercise glycogen contents were 97.7 ± 5.4 and 106.8 ± 4.7 $mmol.kg^{-1}$ w.w. respectively. These differences between treatments were not significant. However, mean muscle glycogen after 60 minutes of passive recovery increased 15.0 ± 4.9 $mmol.kg^{-1}$ w.w., whereas it decreased 6.3 ± 3.7 mmol. Kg^{-1} w.w. following the 60 minutes active recovery protocol ($P < 0.05$). Also the decrease in blood lactate concentration during active recovery was greater than during passive recovery and significantly different at 10 and 30 minutes of the recovery period ($P < 0.05$). These data suggest that the use of passive recovery following intense exercise results in a greater amount of muscle glycogen resynthesis than active recovery over the same duration.

Keywords: high intensity exercise, post exercise activity, muscle glycogen, lactate

Introduction

The role and importance of muscle glycogen content during repeated exercise bouts emphasizes the need for glycogen repletion after exercise, it has been demonstrated that glycogen is significantly increased without carbohydrate feedings 1-2 hours after high

intensity exercise (1, 11, 12), whereas the rate of glycogen resynthesis is considerably lower following prolonged low intensity exercise (10, 13). Therefore, it appears that high-intensity exercise is associated wit glycogen resynthesis during recovery and that either lactate or glucose from the liver or blood could be the source.

Muscle glycogen is one of the main energy sources for athletic performance. However, several questions concerning the resynthesis of glycogen in muscle after exercise remain unanswered. It is a common practice for athletes to "warm down" to decrease the accumulation of lactate in muscle and blood after training or competition. It has been demonstrated that during active recovery or warm down, more lactate disappears than during passive recovery (4, 15, 17). However, from previous studies (5, 16), it is unclear as to the effect of active recovery on the rate and amount of glycogen resynthesis. Several studies indicate that lactate removal from the blood occurs via oxidation during the recovery period after exercise (6, 7). Other evidence suggests that lactate may play a role in glycogen resynthesis following high-intensity exercise, although there has been considerable controversy regarding the ability of skeletal muscle to synthesize glycogen from lactate after exercise (1, 11, 14).

The relationship between active recovery and passive recovery on the rate of glycogen resynthesis has several practical applications. Most athletes perform an active recovery bout to increase the removal of lactate following competition or training. However, the use of active recovery may decrease the rate of glycogen resynthesis following exercise (5). Therefore, this study was designed to examine the influence of active and passive recovery following high-intensity exercise on the magnitude of muscle glycogen resynthesis and lactate removal.

METHODS

Subjects

Six healthy, untrained college-aged males agreed to serve as subjects for this project and gave their written informed consent in accordance with university policies. All procedures were approved by the university Internal Review Board. Descriptive characteristics of the subjects are presented in Table 1.

Table 1: Descriptive Characteristics of the Subjects

Variable	Mean ± SE
Age (yr)	22.7 ± 1.5
Weight (kg)	80.8 ± 5.0
Height (cm)	177.3 ± 3.7
Body fat (%)	12.7 ± 1.7
Lean body mass (kg)	70.3 ± 3.9
VO_2 max (1 min^{-1})	4.1 ± 0.1
Active recovery % VO_2 max	42.3 ± 3.2

Testing Protocol

All subjects signed informed consent documents and were fully acquainted with all procedures prior to testing. The subjects' body fat was estimated using the sum of seven skinfolds. A week prior to the first exercise trial, subjects performed a maximal oxygen consumption (VO_2 max) test to determine the workload for the exercise bouts and during active recovery. This test was conducted on an electronically braked cycle ergometer (Lode-instruments Groningen Holland) and the pedal resistance was increased every 2 minutes until the individual reached volitional fatigue.

The individuals completed two exercise trials separated by at least 1 week. To ensure pre exercise glycogen values were between an optical range of 130-150 mmol. Kg^{-1} w.w., subjects refrained from exercise for 2 days prior to testing, and consumed a 15% carbohydrate solution (300g sucrose in 2000 ml of water) in addition to their normal diet the day before each trial. The exercise protocol for each trial was identical and consisted of three, 1 minute bouts corresponding to 130% of VO_2 max with a 4-minute rest period between each work bout. The exercise trials were followed by one of two types of recovery periods assigned in a randomized, counterbalanced order. In the active recovery trial the subject rode at 40-50% VO_2 max for 30 minutes followed by 30 minutes of seated rest. In the passive recovery trial the exercise protocol was followed by 60 minutes of seated rest.

Data Collection

Prior to exercise, immediately following the third supramaximal exercise bout, and at 60 minutes of recovery, muscle samples were obtained from the vastus lateralis using the needle biopsy technique (3). All samples within each trial were obtained through the same

incision although the angle of entry differed to ensure that samples were taken from different portions of the muscle. The opposite leg was biopsied for the subsequent trial.

A catheter inserted in an antecubital vein was used to obtain blood samples (3ml) 30 second prior to each exercise bout, and at 4, 7, 10, 30 and 60 minutes of the recovery period. Respiratory gases were collected via Douglas bags for 1 minute at 10 and 20 minutes of recovery.

Analytical Methods

All muscle samples were prepared for biochemical analysis, frozen in liquid nitrogen within 30 seconds, and stored until analyzed! Muscle glycogen concentration was determined in triplicate by the fluorometric measurement of glucose residues by HCL hydrolyzation, and recorded as mmol (glucosyl units). Kg^{-1} w.w. (9). Muscle lactate was assayed enzymatically from a wet weight perchloric acid extraction and expressed as mmol. Kg^{-1} w.w. (9).

One-half milliliter of each blood sample was deproteinized in cold perchloric acid for the enzymatic determination of lactate. Serum glucose concentrations were determined from the remaining sample using a hexokinase/glycose-6-phosphate hydrogenase method (sigma chemical Co., procedure No 16 - UV). Respiratory gases were analyzed for oxygen and carbon doxide content using an Applied Electrochemistry S-3A and a sensor Medics LB-2 analyzer, respectively. These instruments were calibrated with gases on known composition before the VO_2 max test and the active recovery trial.

Statistical Analysis

Blood glucose and lactate concentrations were analyzed with a two-way repeated measures analysis of variance using trial and time as repeated factors. Comparisons between means of two differing trials were analyzed by one-way ANOVA (experimental condition). When significance was found, post-hoc comparisons were conducted with Tukey's test. All values were expressed as mean ± SE and statistical significance was accepted at $P < 0.05$

RESULTS

Muscle Glycogen and Lactate Changes

Muscle glycogen results are depicted in Figure 1. The initial muscle glycogen values averaged 144.2 ± 3.8 mmol. Kg^{-1} w.w. for the active trial and 158.7 ± 8.0 mmol. Kg^{-1} w.w. in the passive trial. During the high intensity exercise, muscle glycogen values in the active and passive trials decreased 46.5 ± 5.5. and 51.9 ± 4.7 mmol. Kg^{-1} w.w., respectively. Even

though post-exercise muscle glycogen values were similar between the two trials, there was a significant

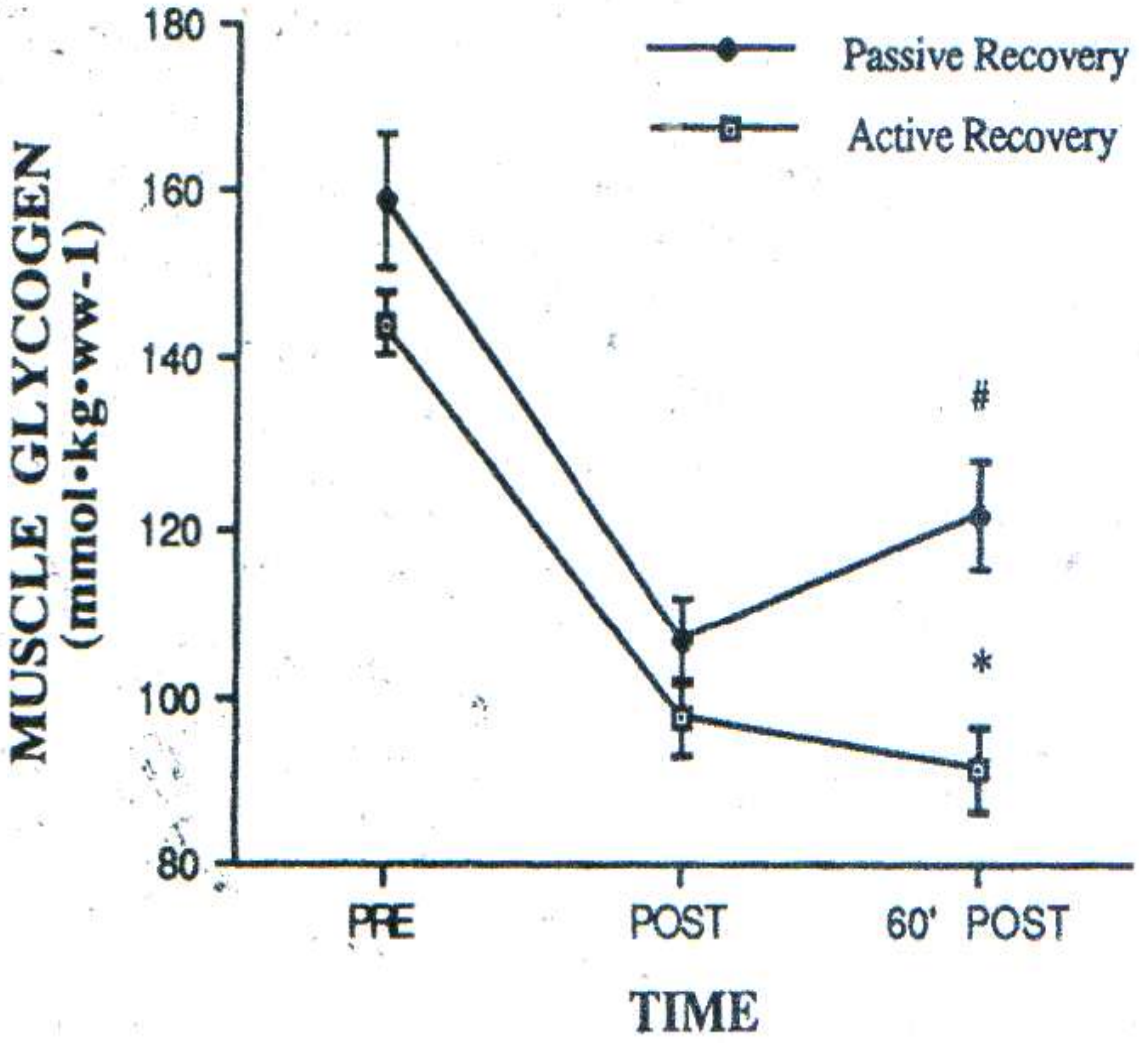


Figure 1—Muscle glycogen response to high-intensity exercise. * Significantly different between trials ($P < 0.05$). # Significantly different from postvalue ($P < 0.05$). Values are mean ± SE.

difference after 1 hour of recovery ($P < 0.05$). during 60 minutes of passive recovery, muscle glycogen significantly increased 15.0 ± 4.9 mmool. Kg^{-1} w.w. ($P < 0.05$), whereas it decreased 6.3 ± 3.7 mmol. Kg^{-1} w.w. during active recovery. The average rate of glycogen resynthesis was 0.3 ± 0.1 mmol. Kg^{-1}. Min^{-1} w.w. during passive recovery.

Muscle lactate concentration was not different between the two trials at any time points (Figure 2). The mean muscle lactate concentration in the active recovery trial increased form 1.53 ± 0.22 mmol. Kg^{-1} w.w. at pre-exercise to 26.21 ± 2.80 mmol. Kg^{-1} immediately after the third exercise bout. In the passive trial it increased from 1.53 ± 0.20 to 25.13 ± 2.41 mmol. Kg^{-1} w.w. After 60 minutes of recovery, the mean muscle lactate concentration in the active recovery trial was 2.35 ± 0.33 mmol. Kg^{-1} w.w. and mean muscle lactate in passive recovery was 1.80 ± 0.11 mmol. Kg^{-1} w.w. The amount of muscle lactate disappearance during the active recovery was 23.85 ± 2.55 mmol. Kg^{-1} w.w. h^{-1} and 23.33 ± 2.34 mmol. Kg^{-1} w.w. h^{-1} during passive recovery.

Serum Glucose and Blood Lactate

Mean serum glucose concentration showed a similar pattern of change in each trial (Figure 3). There were no statistically significant differences between the two trials at any time point ($P < 0.05$). The mean serum glucose value in the active recovery trial was 5.24 (± 0.48) mmol. l^{-1} at pre-exercise and the highest mean glucose value was 7.00 (± 0.76) mmol. l^{-1} at 6 minutes of recovery corresponding mean serum glucose values in the passive recovery were 5.43 (± 0.27) and 6.10 (± 0.44) mmol. l^{-1} respectively.

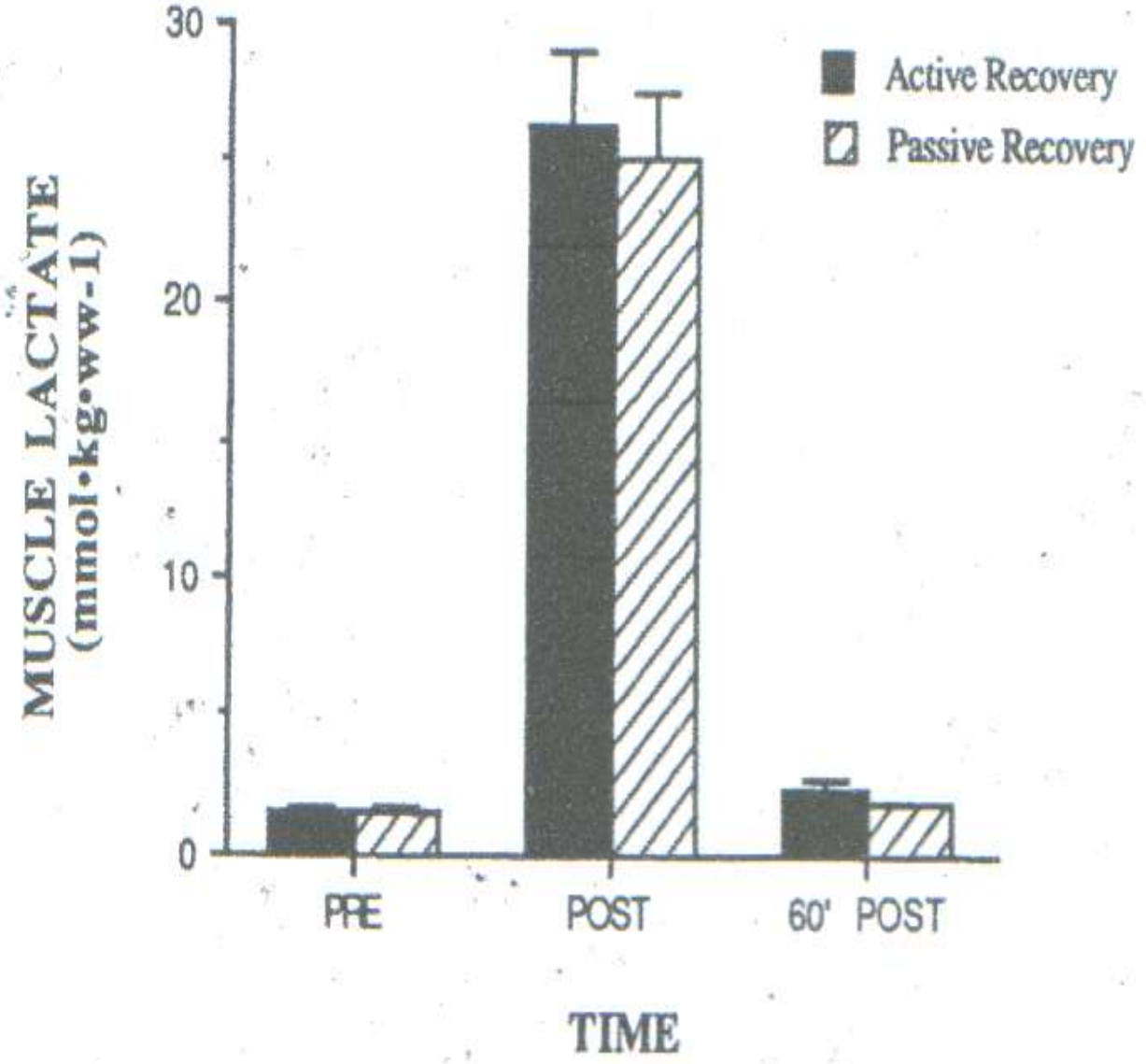


Figure 2—Muscle lactate response to high-intensity exercise. Values are mean ± SE.

Changes in mean blood lactate are presented in Figure 4. The mean blood lactate concentration increased from 1.50 (± 0.25) mmol. l^{-1} at pre-exercise to 12.24 (± 0.90) mmol. l^{-1} at 4 minutes of active recovery, while blood lactate increased from 1.73 (±0.29) to 12.84 (± 0.64) mmol. l^{-1} at 4 minutes of the passive recovery. Significant blood lactate differences were observed between the trials at 10 and 30 minutes of the recovery period ($P < 0.05$). The mean blood lactate values in the active and passive trials were 12.23 (± 0.83) mmol l^{-1} and 9.88 (± 1.26) mmol. l^{-1} at 10 minutes of recovery, respectively ($P < 0.05$).

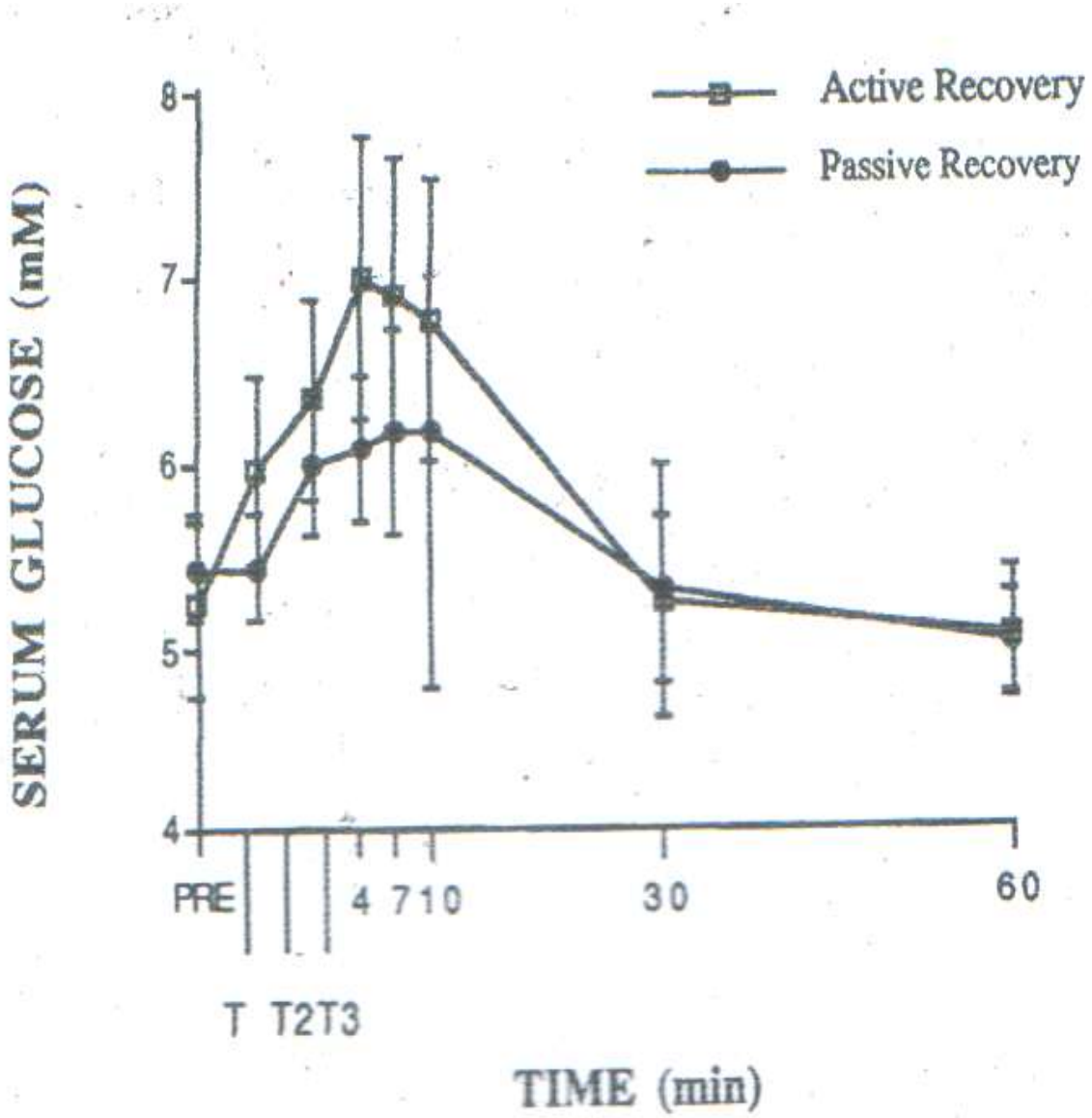


Figure 3—Serum glucose response to high-intensity exercise. Values are mean ± SE.

DISCUSSION

These results are in accord with published reports demonstrating an increase in muscle glycogen content during passive recovery from intense exercise (1, 5, 16). The observed increase in muscle glycogen of 15.0 (± 4.9) mmol.kg^{-1} w.w. during the 60 minutes of passive recovery is in agreement with literature values of 13.5 – 19.0 mmol. kg^{-1} w.w. (1, 5, 16). On

the other hand, our finding that active recovery impedes muscle glycogen resynthesis following intense exercise is both supported (5) and refuted (16) by previously published reports. Bonen et al. (5) noted that muscle glycogen repletion was diminished following exhaustive exercise in exercising and nonexercising muscles when a single-leg active recovery was performed. In addition, they demonstrated not only an inhibition of glycogen repletion but a decrease in muscle glycogen levels when following the same protocol after non-exhaustive exercise. This is in agreement with the data in this study showing a further decrease in glycogen levels from postexercise values following the active recovery period. In contrast, Peters Futre et al. (16) found no significant differences in rates of muscle glycogen resynthesis following intense exercise between active and passive recovery trials. Although non-significant, glycogen synthesis tended to be greater in the passive recovery trial (37.2 vs 24.0 mmol. kg^{-1}w.w. in 90 minutes). A possible explanation for the discrepancy between the results is that their active recovery consisted of a relatively low workload (30% VO_2 max) using only one leg, whereas the present study utilized a two-legged recovery at 42% VO_2 max.

The finding in this study that active recovery resulted in a more rapid decline in blood lactate values is supported by a number of studies (2, 4, 15, 17). The

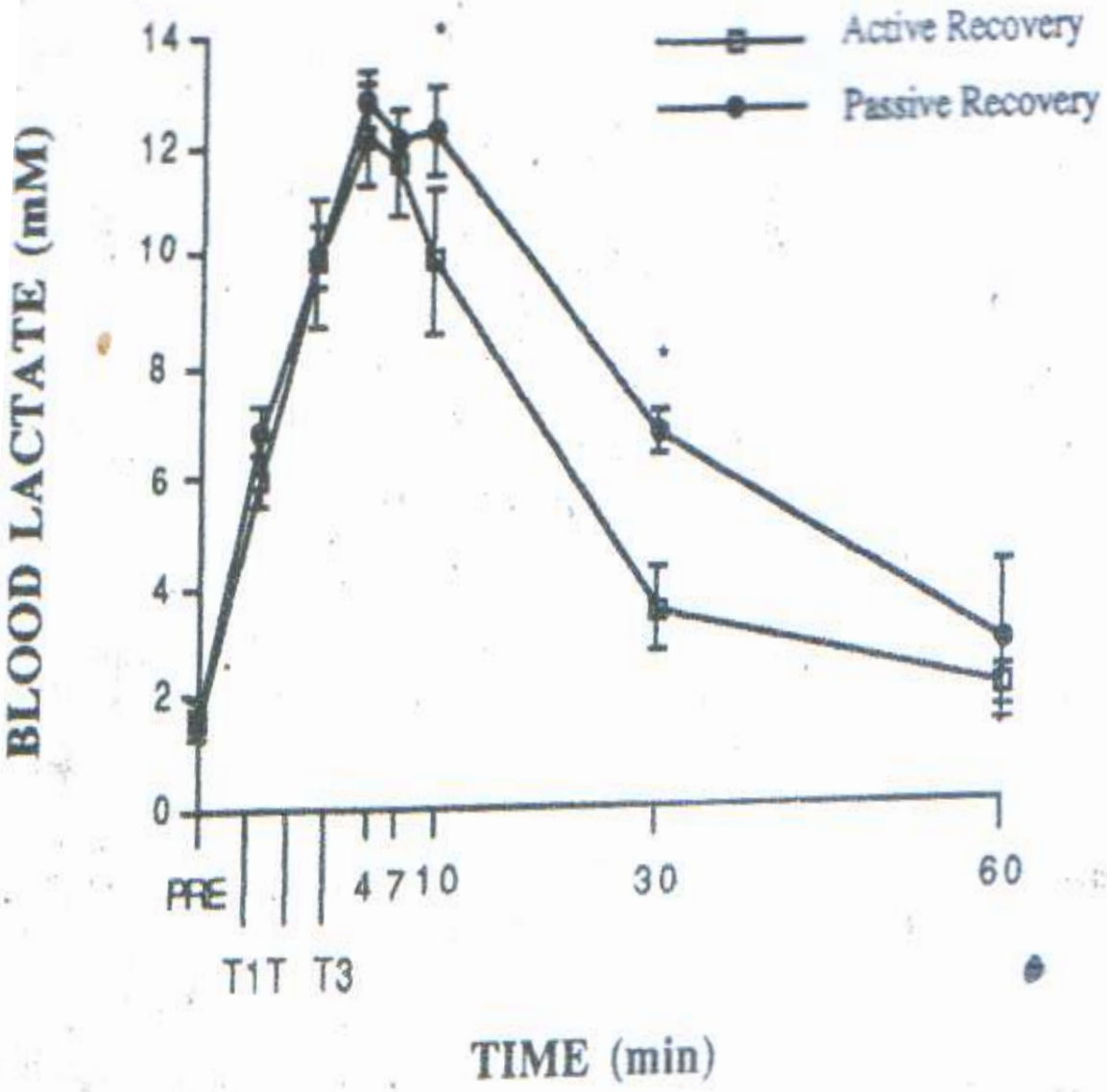


Figure 4—Blood lactate response to high-intensity exercise. * Significantly different between trials ($P < 0.05$). Values are mean ± SE.

recovery intensity of 42% of VO_2 max is nearly identical to the optimal recovery intensity of 43% of VO_2 max for lactate removal reported for cycling exercise by Mclellan and Skinner (15) but higher than the optimal level of 32% of VO_2 max predicted by Belcastro and Bonen (2). Calculated blood lactate removal for the first 30 minutes of recovery was 6.9 $mmol^{-1}$ and 10.5 mmol. l^{-1} for the passive and active recovery periods, respectively. Although lactate values decreased to a significantly greater degree during the active recovery trials, removal rates did not approach the optimal level of 0.49 mmol. l^{-1}. min^{-1} reported by Mclellan and Skinner (15). This may be due to the 30 minutes measurement in the present study being beyond the linear portion of the lactate curve where lactate clearance rates are highest. It is tempting to speculate that lactate levels were decreased with active recovery because the lactate was being oxidized to fuel the recovery activity. However, another possible explanation is that increases in blood flow during active recovery compared with passive recovery resulted in enhanced transport of lactate from the active muscle to removal sites. Regardless of its fate the enhanced clearance of lactate from the bloodstream during active recovery may be of benefit to athletes participating in multi bout sports where increased lactate and the associated decrease in pH may act as a limiting factor.

Even though the rate of blood lactate decline was greater when active recovery was incorporated, muscle and blood lactate levels during both trials rapidly decreased to near pre-exercise levels, indicating that some method of lactate clearance was occurring in both trials. While there are many possible fates of lactate in the post exercise period, the major pathways that have been proposed for its clearance from the muscle are: (1) oxidation to carbon dioxide and water, (2)clearance to the bloodstream where it can be taken to the liver and converted to glucose, and (3) conversion back to glycogen within the muscle via gluconeogenesis (II). A possible explanation for the observed results is that during active recovery, lactate, along with a portion of the remaining muscle glycogen, was oxidized to provide fuel for the recovery activity. During passive recovery, on the other hand, the lactate was not needed as fuel and could, therefore, contribute to the resynthesis of glycogen. This hypothesis is supported by studies that demonstrated human skeletal muscle contains gluconeogenic enzymes necessary for glycogenesis from lactate (8, 14) and those indicating lactate may serve as a major precursor for glycogen resynthesis after exercise (1, 11). However, without more definitive measurements it is not possible to determine the exact fate of lactate in the present study.

Another possible explanation for the reduced rate of glycogen resynthesis during the active recovery protocol is the possibility that exercise during recovery may have continued

to deplete muscle glycogen stores significantly beyond levels measured immediately post exercise. That some degree of glycogen utilization was occurring during active recovery is indicated by the decrease in muscle glycogen values from the immediate post exercise sampling to the 60 minutes post exercise sampling. During the same relative time period that glycogen depletion was occurring during the active trial, glycogen repletion was likely occurring in the passive trial possibly through the incorporation of blood glucose or another glycogenic precursor. When exercise ceased in the active recovery period after 30 minutes, glycogen repletion may have begun but the combination of lower pretesting glycogen stores plus a shorter passive recovery period in which to resynthesize glycogen may have resulted in the observed differences in glycogen repletion levels observed between the two trials at the final sampling point. The previously mentioned study by Bonen et al. (5) supports this hypothesis. They demonstrated a further decline in muscle glycogen with active recovery when it followed non exhaustive exercise but not when it followed exhaustive exercise. While the exercise bout in the present study was considered exhaustive, glycogen levels were decreased to 67.5% of initial levels, which corresponds to the levels seen after the non exhaustive bout (65.7%) but not to those observed after the exhaustive bout (23.3%) in the study by Bonen et al. (5). Thus was likely due to a much shorter duration of exercise being used in the present study. This, the level of glycogen depletion is likely an important determinant of the extent of repletion or further depletion which will occur during an active recovery period.

References:

Astrand, P. O., E. Hultman, A. Julin-Dannfelt, and G. Reynolds. Disposal of lactate during and after strenuous exercise in humans. J.Appl. Physiol. 61:338-343, 1986.

Belcastro, A.N., and A. Bonen Lactic acid removal rates during controlled and uncontrolled recovery exercise J. Appl. Physiol. 39:932-936, 1975.

Bergstrom, J. muscle electrolytes in man Scand J. Clin. Lab. Invest Suppl. 68; 1962

Bonen, A. and A. N. Belcastro. Comparison of self selected recovery method on lactic acid removal rates. Med. Sci. Sports 8:176-178, 1976.

Bonen, A., G. W. Ness, A. N. Belcastro, and R. L. Kirby. Mild exercise impedes glycogen repletion in muscle J. Appl. Physio 58: 1622-1629,1985.

Brooks, G. A., K. E. Brauner, and R. G. Cassens Glycogen synthesis and metabolism of lactic acid after exercise Am. J. Physiol. 224:1162-1166, 1973.

Brooks, G. A. and G.A. Gaesser End point of lactate and glucose metabolism after exhausting exercise J. Appl. Physiol. 49:1057-1069, 1980

Crabtree, B., S.J. Higgins, and E.A. Newsholine. The activities of pyruvate carboxylase and fructose diphosphatase in muscles from vertebrates and invertebrates. Biochem. J. 130. 391-396, 1972.

Fink, W.J. and D.L. Costil. Analytical methods for the measurement. Of human performance. Muncie, IN: Ball state university, 1992. Pp. 38-109.

Gaesser, G.A, and G.A. Brooks. Glycogen repletion following continuous and intermittent exercise to exhaustion. J. Appl. Physiol. 49: 722-728, 1980

Hermansen, L. and O. Vaage lactate disappearance and glycogen synthesis in human muscle after maximal exercise Am. J. Physiol. 223: E 422-E429, 1977.

Macdougall, J. D., G.R. Ward, D.G. Sale, and J. R. Sutton muscle glycogen repletion after high intensity intermittent exercise J. Appl. Physiol. 42: 129-132, 1977.

Maehlum, S. and L. Hermansen Muscle glycogen concentration during recovery after prolonged severe exercise in fasting subjects. Scand. J. Clin. Lab. Invest 38:557-560, 1978.

Mclane, J. A. and J. O. Hollozy. Glycogen synthesis from lactate in the three types of skeletal muscle. J. Biol Chem. 254:6548-6553, 1979.

Mclellan, T. M. and J. S. Skinner. Blood lactate removal during active recovery related to the aerobic threshold Int. J. Sport Med 3:224-229, 1982.

Peters-Future, E. M., T. D. Noakes, R. I. Raine and S. Treblanche. Muscle glycogen repletion during active post exercise recovery. Am. J. Physiol. 253 (Endocrinol Metab. 16); E305-E311, 1987.

Weltman, A, B. A. Stamford, R. J. Moffatt and. V.I. Katch Exercise recovery, Lactate removal, and Subsequent high intensity exercise performance Res. Q. 48: 786-795-1991.

FRESH WATER PRODUCTION BY DESALINATION OF SEA WATER USING SOLAR ENERGY

D. Zioui

R. Bellatreche

H. Aburideh

Z. Tigrine

Solar Equipment Development Unit, UDES, National road N°11, P. O. Box386, Bou-Ismail, 42415, Tipaza,Algeria

Abstract:

In Algeria, as in developing countries, the problem of drinking water is becoming increasingly important, due to the population growth and rising living standards. Desalination of seawater and brackish water is now possible to meet the demand for potable water. Among the various methods, solar distillation is an attractive solution for isolated and remote area. The main objective of the present work is the study of a plan solar still with greenhouse effect. We have especially worked on the determination of operating characteristics, production and other parameters. The performed work is purely experimental and is part within the framework of improving the profitability of a solar still with greenhouse effect. During this period of experimentation, different parameters have been mainly a series of measurements: solar radiation, the temperatures of different parts of the setup (internal pane of glass, internal air, water in the tank ...) and the daily production. The obtained results have allowed us to determine the external and internal parameters influence on the still yield.

Keywords: Solar energy, Desalination, Distillation, Solar still, sea water.

1. Introduction:

Water is the basic necessity for human along with food and air. There is almost no water left on Earth that is safe to drink without purification. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is polluted by both diseases and toxic chemicals. For this reason, purification of water supplies is extremely important. Moreover, typical purification systems are easily damaged or compromised by disasters, natural or otherwise.

This results in a very challenging situation for individuals trying to prepare for such situations, and keep themselves and their families safe from the myriad diseases and toxic chemicals present in untreated water. Everyone wants to find out the solution of above problem with the available sources of energy in order to achieve pure water. Fortunately there is a solution to these problems. It is a technology that is not only capable of removing a very wide variety of contaminants in just one step, but is simple, cost-effective, and environmentally friendly. That is use of solar energy.

A. About Solar Energy

The sun radiates the energy uniformly in all direction in the form of electromagnetic waves. When absorbed by body, it increases its temperature. It is a clean, inexhaustible, abundantly and universally available renewable energy [1].

Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy, especially when other sources in the country have depleted. This solution is solar water distillation. It is not a new process, but it has not received the attention that it deserves. Perhaps this is because it is such a low-tech and flexible solution to water problems. Nearly anyone is capable of building a still and providing themselves with completely pure water from very questionable sources. The energy radiated by the sun on a bright sunny day is 4 to 7 KWh per m2[2]

B. About Solar Still

The first "conventional" solar still plant was built in 1872 by the Swedish engineer Charles Wilson in the mining community of Las Salinas in what is now northern Chile (Region II). This still was a large basin-type still used for supplying fresh water using brackish feed water to a nitrate mining community. Solar water Distillation system also called “Solar Still”. Solar Still can effectively purify seawater & even raw sewage. Solar Stills can effectively removing Salts/minerals {Na, Ca, As, Fe, Mn} ,Bacteria { E.coli, Cholera, Botulinus}, Parasites ,Heavy Metals & TDS[3].

Solar Still Operation

Water to be cleaned is poured into the still to partially fill the basin (fig1). The glass cover allows the solar radiation to pass into the still, which is mostly absorbed by the blackened base. This interior surface uses a blackened material to improve absorption of the

sunrays. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle.

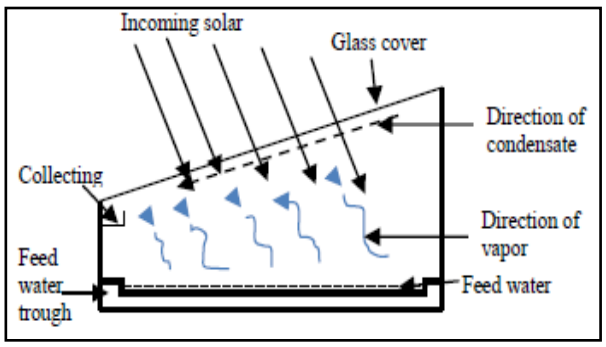


Fig. 1: Basic operation of a conventional solar still.

In the present work, we have examined the temperatures effect of the various still components and the solar radiation on the distiller productivity, and on the other hand, the climatic conditions effect in the town of Bou Ismail-Algeria (located 36° 38' N in latitude and 2° 41' E longitude) on the pure water quality. The obtained results allow us to present the evolution of different temperatures, the quantity of distillate versus time and the physic-chemical analysis of the distillate.

2. Experimental

A basin type solar still is an box formed by an assembling of different materials having the property to produce the phenomenon of green house, thanks to various properties possessed by its constituent materials. The study design is based on the choice of the materials and the variant of distiller.

The materials used have the same functions regardless of the variant of the distiller. We mainly have:

- an absorber [4],
- a transparent glass,
- an insulating material,
- a distilled water evacuation system,
- a brackish water admission system,
- a material for sealing the system,

• and eventually a box.

In this study, a conventional still was constructed. The parameters of the still are given in Table 1.

Table 1: Technical Specifications of Solar still

Specifications	Dimensions	Construction Materials Nature
Basin Area,m^2	1.20	
Glass Area, m^2	1.20	
Glass Thickness, mm	4 mm	
Number of Glass	1	
Slope of Glass	13^0	
Width	1000 mm	
Length	1200 mm	
Basin		concrete
walls		plexiglas
Absorber		bitumen
Distillate recovering system		PVC

The bottom of the tanc is covered by an bitumen layer in order to capture the maximum thermal solar energy.

Temperatures of different components of the still were measured by thermocouples connected to a data logger of fluke type for the acquisition of the data and recorded every one hour from 09:30 - 15:30 PM.

The experimentation began the day filling the basin (10/09/2012) with 26 l of seawater of Fouka which has a salinity of 32.7, an electrical conductivity of 49.9 and a pH =7.87 at a thickness which is not constant. The recovery of produced water is every one hour, which is later analyzed qualitatively and quantitatively.

3. Results and discussion

3.1. *Solar radiation*

The variation of solar radiation received by an inclined glazing surface θ=13°C during 6 days is shown in figure 2. There is a classical bell-shaped variation of the solar radiation. The results show that the solar radiation becomes preponderant and more intensive in the middle of the days which provides maximum energy storage.

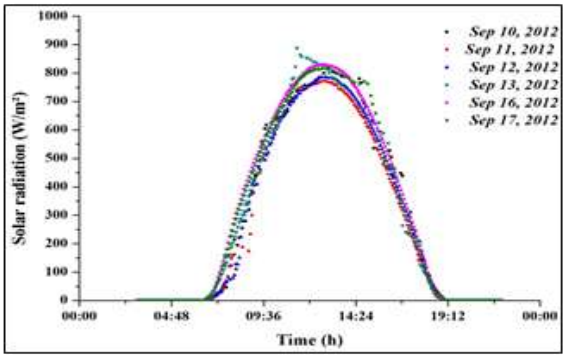


Fig. 2: The evolution of the solar radiation versus the time.

3.2. Temperature evolution

The following figures present the temperature variation of water, concrete, bitumen, inner glass, and outer glass versus time.

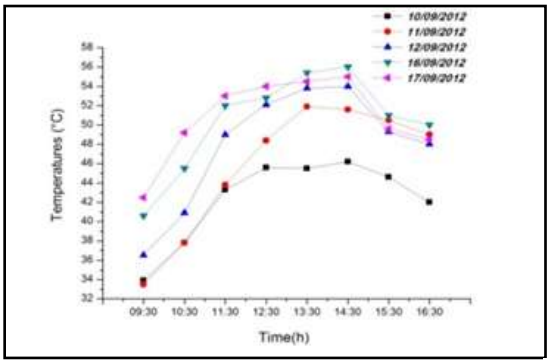


Fig. 3: Evolution of the water temperatures as a function of time for different days

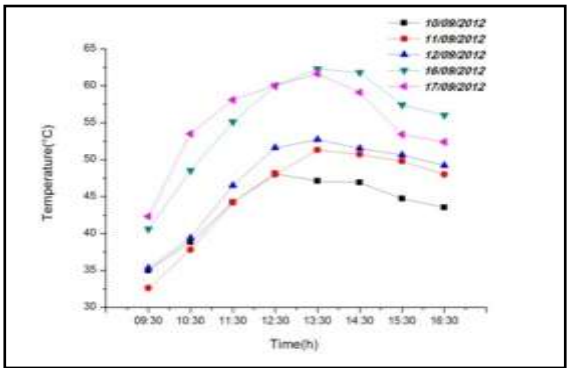


Fig. 4: Evolution of the concrete temperatures as a function of time for different days

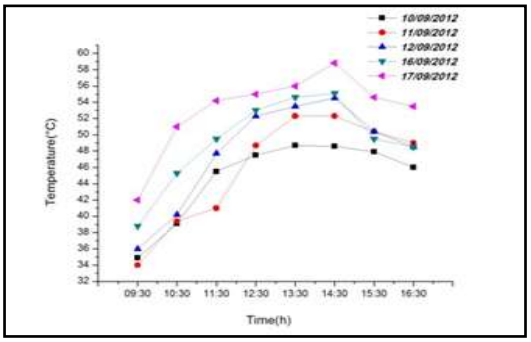


Fig. 5: Evolution of the bitumen temperatures as a function of time for different days

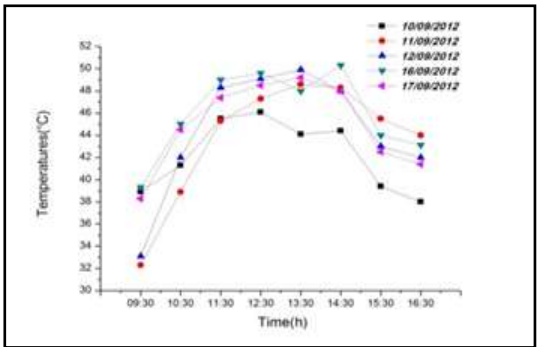
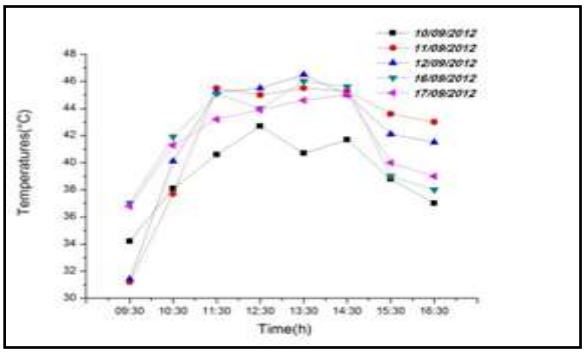


Fig. 6: Evolution of the inner glass temperatures as a function of time for different days



We note that the temperatures of the various components of the distiller vary function of the incident solar flux. They are growing faster than the ambient temperature (greenhouse). The maximum temperature achieved is 60°C and it was recorded for the concrete and bitumen which represents the best medium for thermal energy storage.

Regarding the water, concrete and bitumen temperatures, we clearly see that for the different days its values are proportionally the same, it means that the water temperature depends on the other two temperatures, i.e. if the temperature of the concrete and bitumen increases, it can increase the temperature of the water and hence its evaporation.

The figures 6 and 7 show that the inner glass temperatures are higher than those of outer glass, producing a temperature gradient which allows the condensation water that has evaporated.

3.3. Distillate productivity

The Figure 8 shows as the intensity of solar radiation decreases, so there is a simultaneous decrease in the output. Hence the fresh water production is decreased due to the decline in the intensity of solar radiation and the production reach the maximum between 12:30 and 14:30 for the different days. The maximum value of the produced water which is 270 ml is recorded for the day of 11/09/2012, which was characterized by good meteorological conditions.

The overall amount of distilled water recovered from 26 l is 13,907 l.

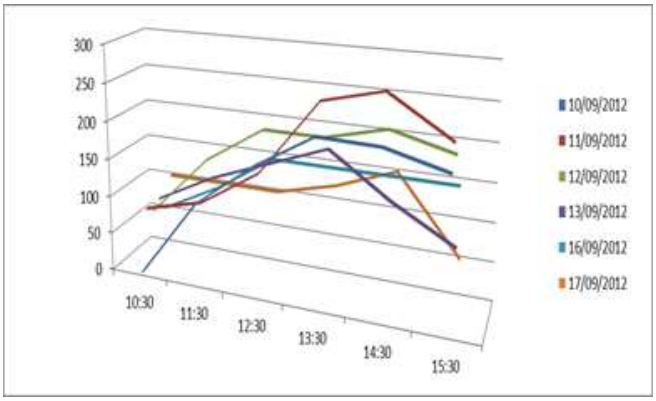


Fig. 8: Hourly fresh water production

3.4. Distillate quality

The pure water recovered was analysed to determine the pH and electrical conductivity. The fig 9 and 10 present the results of measurement of these two.

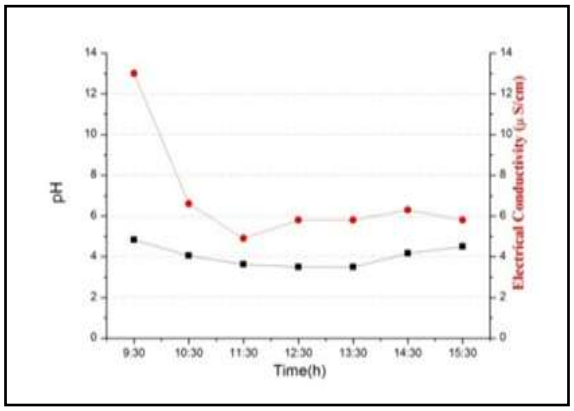


Fig. 9: Variation of pH and conductivity versus the time. (11 sep 2012)

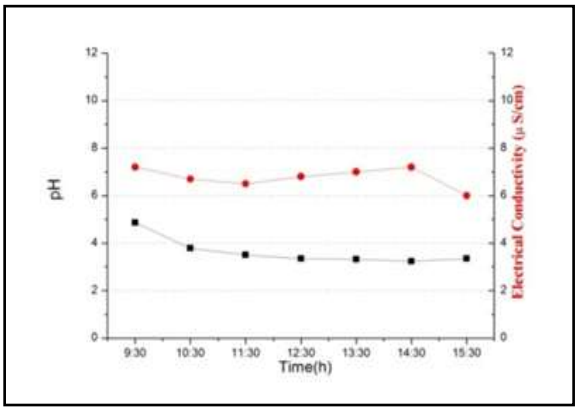


Fig. 10: Variation of pH and conductivity versus the time. (16 sep 2012)

From this figures, it can be seen that the pH present values which are close and they don't exceed a value of 6, this is due to carbon dioxide dissolves in water [5,6]. On the other hand, the electrical conductivity keeps practically the same value except for the day of 11sep 2012 when it reaches 13μs/cm, this can be explained by external factors such as wind which may influence the quality of the distilled water at its collection.

4. Conclusion:

The basin type solar still is a very simple in its execution; it can be made with local materials, which gives it the advantage of being easily used by rural people skilled technically.

Using materials that are very ordinary, we will reach temperatures higher than 60 ° C. With a temperature of this order, the system works until a certain time after sunset.

The temperature variation of different components of the still and the distilled water production depends on the incident solar energy, meteorological conditions…etc.

About the quality of pure water produced, this distiller has allowed us to have water that has a very low electrical conductivity (in the order of μs/cm) in comparing with tap water (in the order of ms/cm) and a pH which is similar to its value in drinking water. Among other things, a volume more than 1 liter of distillate could be recovered from 10:30 to 15:30.

References:

M.A.S. Malik, G.N Tiwari, A. Kumar and M.S. Sodha. "Solar Distillation", Pergamon Press, Oxford, UK, 1982.

Alpesh Mehta, Arjun Vyas, Nitin Bodar, Dharmesh Lathiya. Design of Solar Distillation System. International Journal of Advanced Science and Technology.
2011, Vol. 29, pp 67-74.

A. Kumar, A. Kumar, G.D. Sootha and P. Chaturvadi," Performance of a multi-stage distillation system using a flat-plate collector", Extended Abstract, ISES Solar World Congress, Kobe, Japan, 1989.

F. Mokhtari and D. Semmar ; «The Influence of the absorber Configuration on Thermal Performance of a Solar Air Sensor» ; Journal of Renewable Energies; thermal days ; p. 159-162 ; 2001.

(z)Gysi A. P. and A. Stefa nsson. Numerical modelling of CO2-water-basalt interaction. Mineralogical Magazine, February 2008, vol. 72(1), pp. 55-59.

H. Aburideh, A. Deliou, B. Abbad, F. Allaoui, D. Tassalit and Z. Tigrine. An experimental study of a solar still: Application on the sea water desalination of Fouka. Procedia Engineering 33(2012) 475-484

POLLUTION BIOTIC INDEX AND THE BIOTA INDICATIVE SIGNATURES OF TRANSECTS IN CALABAR RIVER AROUND A BUSY JETTY FACILITY IN CALABAR, NIGERIA

Chinasa Uttah, (MSc)

Department of Geography and Environmental Science, University of Calabar, Calabar, Nigeria

Emmanuel Chukwunenye Uttah (PhD)

Department of Biological Sciences, Cross River University of Technology, Calabar, Nigeria

Christiana Okonofua (MSc)

Department of Biological Sciences, Microbiology Unit, Crawford University, Igbesa, Ogun State, Nigeria

Emmanuel Ogban (PhD)

Department of Biological Sciences, Cross River University of Technology, Calabar, Nigeria

Lawrence Usip (PhD)

Department of Zoology, University of Uyo, Uyo, Nigeria

Jude Ogbeche (MSc)

Department of Biological Sciences, Cross River University of Technology, Calabar, Nigeria

Abstract:

The aim of this work was to assess the environmental quality status transects around a busy jetty facility on the Calabar River estuary using the relative diversity and relative abundance of benthos, phytoplankton and zooplankton as Biota Indicative Signature tools for ascertaining the Pollution Biotic Index. A total of 10 sampling transects were systematically delineated for the study. The sampling transects were spatially located to accommodate various environmental differences in the river course within Calabar including two transects by the jetty facility being studied. The benthic macro-invertebrates samples were collected using Day grab and the collected sediments were washed using a sieve of a 500µm mesh-

size. The benthos specimens were then preserved in plastic containers in 10% formalin with Rose Bengal as vital stain. Pollution Biotic Index (PBI) with 5 categories will be calculated to compare the two expected extremes of water quality. The benthic macro-invertebrates consisted of 58 species in seven classes and four phyla. The Seven major taxonomic groups collected were Gastropoda, Bivalvia, Insecta, Crustacea, Polychaeta, Oligochaeta, and Hirudiae. Insecta was the most abundant representing almost half of the total benthos collected. Phytoplankton accounted for 59.6% of all plankton abundance while zooplankton accounted for 40.4%. The relative abundance of the plankton was comparable in all the study transects. The result of PBI analysis indicated that transects (SS2 & SS3) located directly in the jetty were very heavily polluted while the tidal creek transects (control) were lightly polluted or unpolluted. It can be inferred from the benthic macro-invertebrate study that the minor but incessant discharging of chemical substances from the jetty chemical store into the Calabar River had caused significant perturbation resulting in reduced species richness and abundance. Mitigation measures are needed to halt further discharging of the chemicals.

Keywords: Pollution, Biotic index, Benthic macro-invertebrates, Phytoplankton, Zooplankton, Calabar River

1. Introduction:

There are many methods available for the assessment of environment and water quality. Historically, the monitoring of aquatic ecosystems has been based on chemical measures of water quality. However, current views are that chemical monitoring does not provide sufficient information to enable meaningful conclusions to be drawn (Wright et al., 1993). Consequently, there has been an increase in the use of biological approaches to water quality assessment (Uttah et al. 2008; Uttah and Uttah, 2009; Uttah et al. 2012a,b). It is possible to use any group of organisms to examine the biological condition of a river, and many attempts have been made using both flora and fauna (Armitage et al., 198; Uttah and Uttah, 2009). Fish communities are often used as an indicator of high water quality areas (Uttah et al. 2012a,b), especially salmonids (trout and salmon), as these individuals have extremely specific water quality requirements (Bauer and Ralph, 2001).

The sessile benthic macrofauna are considered to be indicative of environmental status of an ecosystem (Breber et al, 2007). Macro-invertebrates are very useful in monitoring as they are ubiquitous and the number of taxa present offers a range of responses to environmental stresses. Their sedentary nature allows for effective spatial analysis of point-

source pollutants or other impacts; and their relatively long life cycles compared to other groups help in monitoring temporal changes caused by environmental impacts. Furthermore, they have a long history of usage as indicator organisms due to their ease of collection, their immediate and measurable response to impairments reflecting local conditions (Pearson and Rosenberg 1978; Dauer 1993, Bilkovic et al., 2006).

Zooplanktons are rarely important in rivers and streams because they cannot maintain positive net growth rates in the face of downstream losses. However, they are highly sensitive to environmental variation, which results in changes in their abundance, species diversity, or community composition and hence provides important indications of environmental change or disturbance. Zooplankton communities often respond quickly to environmental change because most species have short generation times (usually days to weeks in length). Zooplankton communities respond to a wide variety of disturbances including nutrient loading (Dodson, 1992), acidification (Brett, 1989; Keller and Yan 1991; Marmorek and Kormann 1993), contaminants (Yan et al. 1996), fish densities (Carpenter and Kitchell 1993), and sediment inputs (Cuker 1997).

Environmental audit was carried out on a jetty facility of an oil exploratory company in Calabar. The aim of this work was to assess the environmental quality status transects around a busy jetty facility on the Calabar River estuary using the relative diversity and relative abundance of benthos, phytoplankton and zooplankton as Biota Indicative Signature tools for ascertaining the Pollution Biotic Index..

2. Materials and methods

2.1 Background information on the study area

The jetty facility had been in use for many years but a new oil exploratory company acquired it 9 years preceding the study. Activities that were carried out in the base included general corporate administrative activities, aircraft landing operation and maintenance with a hanger, aviation fuel dump and a busy helipad. Importantly, many hazardous chemicals including biocides were stored at the base. There were serious evidences of major leakages and possibly minor spillages of these hazardous chemicals. All these ran atop cemented floor through channels to the Calabar Estuary. There were three main drainage channels serving the entire facility. The jetty served large vessels that conveyed and brought cargo. There were two fuel dumps: one was a 22,000-litre capacity PMS dump, while the other was a 7,000-litre capacity diesel dump.

2.2 Study design

A total of 10 sampling transects were systematically delineated for the study (Table 1). The sampling transects were spatially located to accommodate various environmental differences in the river course within Calabar including two transects by the jetty facility being studied. Sampling for benthos was carried out in all the 10 sampling transects labeled SS1 to SS10. Sampling for plankton was carried out in five transects labeled SSW1 to SSW5.

Table 1. Study transects and their descriptions

Transects	**Description**
SS1	Upstream of SS2
SS2	Located by the jetty under study
SS3	Located by the jetty under study
SS4	Downstream of SS3
SS5	Tidal creeks
SS6	Tidal creeks
SS7	Downstream
SS8	Downstream
SS9	Downstream area with much anthropogenic activities
SS10	Upstream surrounded by virgin mangrove forests,

2.3 Sampling methods

2.3.1 Benthos

The benthic macro-invertebrates samples were collected using Day grab and the collected sediments were washed using a sieve of a 500μm mesh-size. The benthos specimens were then preserved in plastic containers in 10% formalin with Rose Bengal as vital stain.

2.3.2 Plankton

The sampling methods for phytoplankton and zooplankton have been described in an earlier paper (Uttah *et al*., 2008). For both the phytoplankton and zooplankton studies, plankton net of 55 μm mesh-size was used to collect samples. The plankton nets were towed

horizontally at surface for five minutes at 2 knots for phytoplankton collection.. For zooplankton, the plankton nets were towed vertically from depth subjective to the depth of the sampled station. When retrieved back onto the deck, the collected phytoplankton samples were preserved in 250 ml polyethylene bottles and fixed with Lugol's iodine The zooplankton samples were preserved in 250 ml polyethylene bottles and fixed with 10% formalin. The samples were then transported to the laboratory.

2.4 Laboratory analysis

Sorting and counting of the benthic macro-invertebrates were carried out on the standard white panel in the laboratory. As much as possible, identification of both plankton and benthos specimens was made up to species level or genus levels using the keys of WRC (2001).

2.5 Data analysis

The benthic macro-invertebrate community structure was analyzed using different diversity indexes. Species diversity was analyzed using Margalef index and Shannon-Weaver index. Evenness and dominance were analyzed using Pielou's evenness index and Simpson's Dominance index respectively. These indexes were calculated for each sampling station following standard formulae after Fricova *et al* (2007).

2.6 Determination of Pollution Biotic Index

Tidal creeks interspersed with mangrove trees are known to be of high environmental quality. In this study, such high quality ecosystem will be represented by transects SS5 & SS6. These two transects will be compared with the two transects (SS2 & SS3) located directly in the primary source of chemical discharge from the jetty facility. The PBI of the four sampling transects will be calculated to compare their environmental quality status. The Pollution Biotic Index (PBI) with 5 categories will be calculated after Tuffery and Verneaux, (1968) to compare the two expected extremes of water quality (see Table 2). The Microsoft Office Excel 2007 edition was used for data entry and analysis.

Table 2. Categories of the Pollution Biotic Index **(**PBI) and their indications after Tuffery and Verneaux (1968)

Category	**PBI**	**Significance**
I	10 – 9	Lightly or unpolluted
II	8 – 9	Slightly polluted
III	6 – 5	Moderately polluted – critical situation
IV	4 – 3	Heavily polluted
V	2 - 0	Very heavily polluted

3. Result

3.1 Benthos

The benthic macro-invertebrates consisted of 58 species in seven classes and four phyla. The Seven major taxonomic groups collected were Gastropoda, Bivalvia, Insecta, Crustacea, Polychaeta, Oligochaeta, and Hirudiae (Table 3). Insecta was the most abundant representing almost half of the total benthos collected.

Table 3. Relative abundance of major taxa of benthic macro-invertebrates

Taxa	Abundance	Percentage (%)
Hirudiea	15	4.1
Oligochaeta	39	10.7
Polychaeta	43	11.9
Crustacea	55	15.2
Insecta	179	48.8
Bivalvia	16	4.4
Gastropoda	18	5.0
Total	365	100.00

The relative abundance and diversity of benthic macro-invertebrates in relation to the study transects is presented in Table 4. Relative abundance was highest in Transects SS! And SS10. The highest number of species of benthos was collected from Transect SS7. Transect SS7 also posted the highest indices of diversity (Margalef Index) and evenness (Shannon Weiner index).

Table 4. Percentage Abundance and Diversity indices of Macro-benthos in relation to the study transects

Transect	Abundance (%)	No. of Species	Margalef Index	Shannon Weiner index
SS1	50 (13.7)	18	4.346	2.751
SS2	42 (11.5)	9	2.14	2.078
SS3	31 (8.5)	8	2.038	1.527
SS4	35 (9.6)	16	4.219	1.96
SS5	24 (6.6)	10	2.832	1.948
SS6	30 (8.2)	10	3.909	2.24
SS7	39 (10.7)	24	6.278	3.12
SS8	35 (9.6)	17	4.500	2.758
SS9	33 (9.0)	15	4.004	2.491
SS10	46 (12.6)	19	4.701	2.618

3.2 Plankton

Phytoplankton accounted for 59.6% of all plankton abundance while zooplankton accounted for 40.4%. The relative abundance of phytoplankton (Table 5) shows that diatoms accounted for 60.8% of total phytoplankton abundance. For zooplankton, copepods were the predominant taxonomic group especially the Calanoids that accounted for 52.1% of total zooplankton abundance (Table 6).

Table 5. Summary of relative abundance of phytoplankton divisions

Divisions	Abundance	Percentage (%)
Chlorophyceae	33	7.7
Cyanophyceae	19	4.4
Diatoms	260	60.8
Dinoflagellates	91	21.3
Xanthophyceae	3	0.7
Miscellaneous	22	5.1
Total	428	100.0

Table 6. Summary of relative abundance of major zooplankton groups

Taxon	Abundance	Percentage (%)
Protozoa	43	14.8
Copepoda larvae	6	2.1
Copepoda/Calanoida	151	52.1
Copepoda/Cladocera	23	7.9
Copepoda/Cyclopoida	11	3.8
Annelida/Polychaeta larvae	12	4.1
Chaetognatha	7	2.4
Rotifera	31	10.7
Pisces larvae	6	2.1
Total	290	100

The relative abundance and diversity index of plankton in relation to the study transects is presented in Table 7. The relative abundance of the plankton was comparable in all the study transects. Similarly the number of phytoplankton and zooplankton species collected was comparable in all the study transects.

Table 7. Abundance and diversity indices of plankton in relation to the transects

Transect	Phytoplankton			Zooplankton			Total	
	Abundance (%)	**No. of Species**	**Margalef Index**	**Abundance (%)**	**No. of Species**	**Margalef Index**	**Abundance (%)**	**No. of Species**
SW01	85 (19.9)	26	5.63	58 (20)	24	5.664	143 (19.9)	50
SW02	84 (19.6)	26	5.64	60 (20.7)	20	4.641	144 (20.1)	46
SW03	97 (22.7)	29	6.12	65 (22.4)	20	4.552	162 (22.6)	49
SW04	80 (18.7)	27	5.93	64 (22.1)	23	5.290	144 (20.1)	50
SW05	82 (19.2)	29	6.35	43 (14.8)	19	4.786	125 (17.4)	48
	428 (100)			**290 (100)**			**718 (100)**	

Determination of Pollution Biotic Index

The PBI of the transects located directly by the jetty (SS2 and SS3) were calculated and compares with the PBI of the two transects located in tidal creeks (SS5 and SS6) as shown in Table 8. The result indicated that transects (SS2 & SS3) located directly in the jetty were very heavily polluted while the tidal creek transects (control) were lightly polluted or unpolluted.

Table 8. Comparison of Pollution Biotic index of the two tidal creek sampling transects and the two sampling stations nearest to Addax jetty.

Transect	Type	Biotic index	Significance
2	Addax jetty	1	Very heavily polluted
3	Addax jetty	1	Very heavily polluted
5	Tidal creek	9	Lightly or unpolluted
6	Tidal creek	9	Lightly or unpolluted

Discussion

Community structure and distribution of macrozoobenthos showed that crustaceans dominated in all the sampling transects followed by polychaetes, oligochaetes and mollusks. The benthic macro-invertebrates species composition observed in this study was identical to that of other proximal water bodies of similar size and ecology (Uttah and Uttah, 2009). The observed dominance of crustacea is in tandem with popular observation that crustacea is by far the most diverse taxonomic group in fresh water (Hutchinson, 1993).

The macro-invertebrate communities in the tidal creeks were of relatively higher diversity and abundance when compared with communities of transects 2 and 3, which were source points of chemical waste discharges from the jetty. Industrial discharges are known to contain high concentrations of Cadmium and Lead which may be injurious to some benthos species but favourable only to opportunistic species.

In transect 10 which is upstream the Calabar River, surrounded by virgin mangrove forests, there was high species richness in both seasons showing availability of many micro-niches characteristic of stable ecosystems. On the other hand, the significantly reduced species richness at sampling transects 2 & 3 are indicative of presence of stressors. This is confirmed by the presence of benthic species that are found in heavily organically polluted water such as rattail, *Eristalis* (Odiete, 2003). There are signs of slight improvement further

downstream at station 4 with the emergence of pollution-sensitive species such as bivalves and crustaceans. Further downstream in transect 9 where there was evidence of tremendous anthropogenic activities, and this perhaps, was responsible for reduction in species richness in this station in both seasons, which is characteristic of stressed system (Uttah and Uttah, 2009).

Generally, in freshwater sediments, benthic macro-invertebrates are diverse and abundant, but they are often patchily distributed and relatively difficult to sample, especially when they dwell in deep subsurface sediments. However, alterations in the complex connections among sediment-dwelling species and associated food webs may precipitate changes in freshwater ecosystems (Goedkoop and Johnson 1996, Lodge *et al*.1998b, Stockley *et al*. 1998). Precursors of change in species composition of benthos include anthropogenic activities such as watershed land use that causes sediment contamination (Uttah *et al*. 2012b); floods or drought (Covich 1993, Power 1995, Johnson et al,. 1998); excessive fluctuations in salinity, harmful microalgal blooms, anoxic crises, too much or too little marine penetration, and excessive turbidity (Breber, 1997).

Microhabitats exist in aquatic ecosystems and numerous zoobenthic species occupy particular microhabitats along stream channels or at various depths in lakes (Hutchinson 1993) and at various times of year (Cummins *et al*. 1989). These spatial and temporal distributions suggest that benthic species have different preferences for particular ranges of temperature, pH, current velocity, and types of substrata. Colonization studies of streams and rivers also suggest that there are important differences in preferred use of microhabitats (Milner 1987, Malmqvist *et al.* 1991). These differences in the ability of species to disperse to and live in certain microhabitats become especially important after major disturbances, when species abundances and community structure may shift resulting in changes in species composition.

In the determination of Pollution Biotic Index, two categories of sampling transects were compared. These are transects 5 and 6 representing Tidal creeks interspersed with mangrove trees, known to be of high environmental quality; and transects 2 and 3 which are located directly in the primary source of chemical discharge from the jetty. A comparison of the two groups of sampling transects indicated that the transects located directly in the jetty were very heavily polluted while the tidal creek transects were slightly polluted or unpolluted. It can be inferred from the benthic macro-invertebrate study that the minor but incessant discharging of chemical substances from the jetty chemical store into the Calabar

River had caused significant perturbation resulting in reduced species richness and abundance. Mitigation measures are needed to halt further discharging of the chemicals.

Conclusion:

Protecting diverse benthic communities will require more thorough understanding of long-term functional relationships among these species in an ecosystem context. To this end, enlightenment campaigns by Government and corporate bodies should become desiderata.

High pollution level will affect the sustainable development of the resources of the Calabar River estuary. There should be a regular monitoring of activities of individual and corporate users of our aquatic systems to ensure sustainability of the integrity of the environment. This should be done in such a way that offenders are brought to book.

References:

Clancy, Armitage, P.D., D. Moss, J.F. Wright, and M.T. Furse. 1983. "The Performance of a New Biological Water Quality Score System based on Macroinvertebrates over a Wide Range of Unpolluted Running-Water Sites". *Wat. Res.* 17: 333-347.

Bauer, S.B and S.C. Ralph. 2001. Strengthening the use of aquatic habitat indicators in the Clean Water Act programs. Fisheries 26(6):14-25.

Bilkovic, D.M. Roggero, M., Hershner, C.H., And K. H. Havens (2006). Influence of Land Use on Macrobenthic Communities in Nearshore Estuarine Habitats *Estuaries and Coasts* Vol. **29**, No. 6B, p. 1185–1195.

Breber P 1997. The ideal salinity regime in Mediterranean lagoons. In: Özhan, E. (ed.), 1997. Proc. *3rd Interntl. Conf. Mediterranean Coastal Environment, MEDCOAST '97*. Vol. I: 91-96.

Breber P, Cilenti L, Pagliani T, Savino B, Spada A, Strada R, Scirocco T 2007. La valutazione della qualità ambientale delle lagune. *Biologi Italiani* **31**(6): 42-46.

Brett, M.T. 1989. Zooplankton communities and acidification processes (a review). Water, Air, and Soil Pollution 44: 387-414.

Carpenter, S.R. and J.F. Kitchell. 1993. The trophic cascade in lakes. Cambridge University Press. Cambridge, U.K.

Covich, A.P., Palmer, M.A. and Crowl, T.A. (1993). The Role of Benthic Invertebrate Species in Freshwater Ecosystems Zoobenthic species influence energy flows and nutrient cycling *BioScience* **Vol. 49** No. 2.

Cuker, B.E. 1997. Field experiment on the influence of suspended clay and P on the plankton of a small lake. Limnology and Oceanography 32: 840-847.

Cummins, K.W., M.A. Wilzbach, D.M. Gates, J.B. Perry, and W.B. Taliaferro. 1989. Shredders and riparian vegetation. *Bioscience* 39(1):24-30.

Dauer, D. M. 1993. Biological criteria, environmental health and estuarine macrobenthic community structure. Marine Pollution Bulletin 26:249–257.

Dodson, 1992), Dodson, S. (1992). Predicting crustacean zooplankton species richness. Limnol. Ocennogr., 37(4), 1992, 848-856.

Fricova, B., Ruzickova, J. and Hrebik, S. (2007). Benthic macro-invertebrates as indicators of ecological integrity of lotic ecosystems in the Sumava National Park, Czek Republic. *Silva Gabreta* **13** (1): 39-55.

Goedkoop W, Johnson RK. 1996. Pelagic–benthic coupling: Profundal benthic community response to spring diatom deposition in mesotrophic Lake Erken. Limnology and Oceanography 41: 636–647.

Hutchinson, G. E. 1993. A treatise on limnology. V. 4. The zoobenthos. Y. H. Edmondson [ed.]. John Wiley & Sons, Inc., NY. 944 p.

Johnson SL, Covich AP, Crowl TA, Estrada A, Bithorn J, Wurtsbaugh WA. 1998. Do seasonality and disturbance influence reproduction in freshwater atyid shrimp in headwater streams, Puerto Rico? Proceedings of the International Association of Theoretical and Applied Limnology 26: 2076–2081.

Keller and Yan 1991; Keller, W. and N.D. Yan. 1991. Recovery of crustacean zooplankton species richness in Sudbury area lakes following water quality improvements. *Canadian Journal of Fisheries and Aquatic Sciences* 48: 1635-1644.

Lodge DM, Stein RA, Brown KM, Covich AP, Bronmark C, Garvey JE, Klosiewski SP. 1998b. Predicting impact of freshwater exotic species on native biodiversity: Challenges in spatial and temporal scaling. Australian Journal of Ecology 23: 53–67.

Malmqvist B, Rundle S, Bronmark C, Erlandsson A. 1991. Invertebrate colonization of a new, man-made stream in southern Sweden. Freshwater Biology 26: 307–324.

Marmorek, D.R. and J. Korman. 1993. The use of zooplankton in a biomonitoring program to detect lake acidification and recovery. Water, Air, and Soil Pollution 69: 223-241.

Milner AM. 1987. Colonization and ecological development of new streams in Glacier Bay National Park, Alaska. Freshwater Biology 18: 53–70.

Odiete, W.O., Nwaokoro, R.C. and Adaramola, T. (2003). Biological assessment of four watercourses in Lagos metropolis receiving industrial and domestic waste discharges. *Journal of Nigerian Environmental Society*, 1(**1):** 1-14

Pearson, T.H. and Rosenberg, R. (1978). Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology: An Annual Review 16:229–311.

Power ME. 1995. Floods, food chains, and ecosystem processes in rivers. Pages 52–60 in Jones CG, Lawton JH eds. Linking Species and Ecosystems. New York: Chapman and Hall.

Stockley RA, Oxford GS, Ormond RFG. 1998. Do invertebrates matter? Detrital processing in the River Swale-Ouse. Science of the Total Environment 210: 427–435.

Tuffery, G. and Verneaux, J. (1968). "Methode de determination de la qualite biologique des eaux courantes." Ministere de l'agriculture, France, pp. 1-23.

Uttah, E.C., Uttah, C., Akpan, P.N., Ikpeme, E., Ogbeche, J., Usip, L., and Asor J. (2008). Bio-survey of Planktons as indicators of water quality for the suitability of River Cross in Calabar, Nigeria for recreational activities *Journal of Applied Sciences and Environmental Management,* **12** (2): 35-42.

Uttah, E.C. and Uttah, C. (2009). Biotic assessors of environmental integrity in an area hosting oil exploratory activities in the Niger Delta, Nigeria. Environmental Analar. 13: 1555-1558.

Uttah, C., E. Uttah, and I. Ayanda. 2012b. "Environmental Quality Assessment of Anthropogenically Impacted Estuary using Fish Genera Composition, Tissue Analysis, and condition Factor". Pacific Journal of Science and Technology. 13(2):537-542.

Uttah, C., Uttah, E.C., and Akubuenyi, F. (2012b). Ascertaining environmental quality status of aquatic systems in Ikot Abasi, Nigeria using fish ectoparasites, fish health and diversity protocols. Transnational Journal of Science and Technology 2 (5): 76-89.

Wright, J.F., M.T. Furse, and P.D. Armitage. 1993. RIVPACS: A technique for evaluating the biological quality of rivers in the UK. *European Water Pollution Control* 3(4):15-25.

WRC, (2001). *Water quality and macroinvertebrates.* Water Facts 2. Water and Rivers Commission WN10, Perth. 12pp.

Yan et al. 1996), Yan, N.D., W. Keller, K.M. Somers, T.W. Pawson, and R.E. Girard. 1996. Recovery of crustacean zooplankton communities from acid and metal contamination: comparing manipulated and reference lakes. Canadian Journal of Fisheries and Aquatic Sciences 53: 1301-1327.

NUTRITIONAL EVALUATION OF CATTLE RUMEN EPITHELIAL TISSUE SCRAPINGS MEAL FOR GROWING RABBITS

Isaac Omoniyi Oladunjoye,
Johnson Adeleke,
Banji Famakinwa

Department of Animal Production and Health, Ladoke Akintola University of Technology, P.M.B. 4000 Ogbomoso, Oyo State, Nigeria.

Ojeniyi Olusegun Ojebiyi,

Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, P.M.B.4000 Ogbomoso Oyo State, Nigeria.

Corresponding author: Dr oladunjoye Isaac Omoniyi, Department of AnimalProduction and Health , Ladoke Akintola University of Technology, PMB 4000, Ogbomoso

Abstract:

Replacement of fish meal with cattle rumen epithelial tissue scrapings meal (CRETSM) in growing rabbit's diet was studied in a 56 day trial to explore the possibility of recycling this waste and reduce feed formulation cost. One hundred and twenty growing rabbits were divided into six groups of twenty rabbits each which was assigned to six diets that had 0, 20, 40, 60 80 and 100 percent fish meal in it replaced with CRETSM in a Completely Randomized Design. Data collected were feed intake, weight gain, feed: gain ratio, production cost, carcass characteristics and nutrient digestibility. Data were analyzed by ANOVA. Weight gained by the rabbits fed 0, 20, 40, 60 and 80 percent fish meal in their diets replaced were similar but were higher ($P<0.05$) than that fed only CRETSM. Similar trend was observed in carcass weight and protein digestibility. Feed cost decreased with increase level of CRETSM in the diets while production cost was lower for the rabbits fed diets that contained CRETSM. Poor feed utilization was observed in the rabbits fed only CRETSM. Feed intake, organ weights and nutrient digestibility were unaffected. It was concluded that CRETSM can replace 80% fish meal in growing rabbit diet.

Keywords: Carcass characteristics, feed:gain ratio, feed intake, nutrient digestibility, weight gain

Introduction

Recent increases in the price and demand of fish meal, the primary protein source in livestock and fish feed call for a search for alternative protein sources (Duangrat *et al*, 2010). The search for unconventional animal feed protein sources is not a recent issue and many studies have been carried out. These include the use of meat meal, hatchery waste (Sathishkumar and Prabakaran, 2008), earthworm meal, maggot meal (Adeniji 2007), Shrimp meal (Aktar,*et al.* 2011) and cattle rumen epithelial tissue scrapings (Bawala *et al*, 2007 and Ogunwole , 2011). The most suitable solution to the problem of high cost of conventional animal protein sources may be the exploitation of vast, cheap and available and underutilized slaughterhouse wastes and animal by products which often constitute environmental pollutants (Ogunwole, 2011).

Cattle rumen epithelial scraping is an abattoir by product that results from cleaning rumen for human consumption in most African countries including Nigeria and it consists mainly of papillae layer. Rumen epithelial scrapings is readily available in Nigeria since over 1 million heads of cattle are slaughtered annually excluding sheep and goat which yield related products. It has been estimated that an average of 0.6Kg of this product can be obtained from an adult slaughtered beef cattle when processed. Studies have shown that rumen epithelial tissue scraping meal has some benefits in the nutrition of ruminant animals (Ogunwole, 2011). However, there is a dearth of information on its use as a protein source for rabbit. The use of cattle rumen epithelial tissue scrapings which is a waste as protein source for rabbit could be a way of reducing the cost of producing rabbit pellets which is often needed to achieve maximum production potential for the breeding stock without creating food/feed crisis that is associated with poultry and pig production. This study was therefore designed to study the effect of substituting cattle rumen epithelial tissue scrapings for fish meal a conventional protein source on the production performance of the growing rabbits.

Materials and Methods

Experimental Site:

The study was carried out at the Rabbitary Unit of the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Oyo State , Nigeria. The location of the study fall between latitudes $8^0$07'N and $8^0$12'N and longitudes $4^0$04'E and $4^0$15'E. The mean annual rainfall is 1247mm with relative humidity of between 75 and 95%. It is situated at about 500mm above the sea level with a mean annual temperature of 26.2^{0}C.

Collection and processing of Test Ingredients:

The cattle rumen epithelial tissue scraping that was used in this study was collected from Bodija abattoir, Ibadan and Ogbomoso township slaughter slab all in Oyo State , Nigeria. The wet material was pressed free of water and poured into a pot containing boiling water (100^0C) where it remained for 30 minutes to kill the pathogenic organisms that may be present. The boiled material was then drained of water, dried in the sun for 7 days and milled to obtain what was referred to as Cattle Rumen Epithelial Tissue Scrapings Meal (CRETSM). A sample of CRETSM was collected and stored in a sealed bottle for laboratory analysis.

Experimental Diets:

Control diet was formulated to contain 2% fish meal as animal protein source. Cattle rumen epithelial tissue scraping was used to replace 20% (diet 2), 40% (diet 3), 60% (diet 4), 80% (diet 5) and 100% (diet 6) percents fish meal in the control (diet 1). All diets were iso-nitrogenous and iso-caloric. The gross composition of the diets is shown in Table 1. The formulated diets were processed into pellet form using 4mm pelleting machine to ensure adequate feed intake and avoid wastage.

Experimental Animals and Management:

One hundred and twenty mix sex cross bred of Newzealand and Flemish giant growing rabbits average 0.94±8g were used for the study. The rabbits were divided into six groups of 20 rabbits each on equal weight. The six groups were randomly assigned to the six diets in a Completely Randomized Design (CRD). Each rabbit in a treatment was a replicate and was housed individually in a wooden hutch of 60×50×45cm with the floor and sides covered with wire netting. Each hutch was equipped with earthen vessels for water and feed and collecting tray at the base to avoid feed wastage and ease faecal collection. Feed and water were supplied *ad libitum* twice a day (8am and 4pm). The rabbits were treated for lice, mange and intestinal worms using ivomectin and allowed to acclimatize prior to the commencement of the experiment. The study lasted for 56 days.

Data collection:

Record of feed intake was collected by measuring the feed offered and the left over after 24 hours period using weighing scale. Feed consumed for the day was therefore calculated as feed offered minus left over the following day. Weights of the rabbits were taken at the beginning of the experiment and weekly thereafter using electronic weighing

scale. The difference in the weights of the rabbit in two successive weeks was taken as the weight gain/change for that week. Feed to gain was determined as feed consumed per unit weight gain.

$$\text{Feed to gain ratio} = \frac{\text{Feed Intake}}{\text{Weight Gain}}$$

Feed cost was calculated from the prices of the ingredients used in feed preparation. The price of CRETSM was estimated from the costs of transportation, labour and energy for boiling. Feed cost per kilogram weight gain was determined from the price of feed per kilogram and feed to gain ratio.

Carcass evaluation:

Twelve rabbits that had their weights close to the mean for the treatment group were selected for carcass evaluation. The rabbits were fasted for 24 hours, properly tagged, weighed, stunned and bled by neck slit using sharp knife. The rabbits were skinned, eviscerated, dressed and the dressed weight taken using electronic weighing scale. Carcass yield was calculated by expressing the dressed weight as the percentage of the live weight of the rabbit. Internal organs (Liver, kidneys, heart, lungs and spleen) were carefully excised, clean of blood, weighed and the weights also expressed as the percentage of the live weight of the rabbits. Abdominal fat was also carefully scraped, weighed and the weight expressed as the percentage of the live weight of the rabbit.

Digestibility trial:

Digestibility trial was conducted at the end of the study using 12 rabbits per treatment. Rabbits were housed individually in hutches equipped with collecting trays for easy collection of faeces and waste feed. The rabbits were allowed 5 days adjustment period followed by another 5 days collection period. Faeces voided was collected, weighed and dried in the oven at 60^0C for 72 hours. Faeces from each treatment was bulked, milled and representative samples collected in sealed bottles for laboratory analysis.

Chemical analysis:

Feeds, faecal samples, CRETSM and fish meal were analyzed for moisture, crude protein, crude fiber and ether extract using AOAC methods (AOAC, 1990). Methionine and lysine contents of CRETSM and fish meal were determined using high performance liquid

chromatography technique as described by Ijarotimi and Olapade (2009) after the hydrolysis of the samples. Phosphorus was determined using a spectrophotometric phosphoammonium vanadate reaction as described by Ravindra and Sivakanesan (1995). Calcium, magnesium, manganese, iron and zinc were determined using Perkin-Elmer Model 2380 atomic absorption spectro-photometer after wet digestion of the samples. Sodium and potassium were determined in the ash solution by emission spectroscopy at acetylene gas flame (AOAC, 1995).

Statistical analysis:

Data were analyzed by one-way analysis of variance using the General Linear Model procedure of SAS (SAS 1998). Significance was determined at $P<0.05$ and where significance were indicated, Least Significance Difference (LSD) was used to separate the means.

Results

The composition of CRETS and fish meal used in this study is shown in Table 2. The crude protein content of fish meal (65.72%) was slightly higher than that of CRETS (64.61%). Fish meal also had higher fat (14.63% Vs 8.20%), ash (11.84% Vs 5.60%), methionine (1.12% Vs 0.98%), calcium (7.12% Vs 3.07%), phosphorus (3.16% Vs 2.20%) sodium (0.38% Vs 0.22%), Zinc (63.32ppm Vs 23.21ppm) and manganese (12.96 Vs 8.24ppm) than CRETS. However, CRETS had higher crude fiber (3.58%Vs 0.51%), nitrogen free extract (18.01% Vs7.30%), lysine (3.80 Vs 3.51%) and iron (398ppm Vs 190ppm) than fish meal.

The performance characteristics and economic implication of substituting CRETS for fish meal in growing rabbits is presented in Table 3. No significant effect of dietary treatments was observed in the weight gain of the rabbits that had 20% (14.7g), 40% (15.0g), 60% (15.1g) and 80% (15.4g) of fish meal in their diets replaced with CRETSM and those that were fed control diet (14.4g). However, significant ($p<0.05$) depression was observed in the weight gain of those that had 100% fish meal (13.2g) in their diets. The feeds consumed by the rabbits were not significantly ($p>0.05$) different across the treatments. Feed to gain ratio of the rabbits that were fed control diet, 20%, 40%, 60%, and 80% CRETSM were similar but were lower ($p<0.05$) than those fed CRETSM as the sole animal protein source (100%CRETSM).

Feed cost in Naira decreased with increase level of CRETSM substitution in the diets. Values obtained were 55.8, 54.5, 51.2, 50.9 and 47.2 for the control, 20%, 40%, 60%, 80% and 100% CRETSM diets respectively. Feed costs per kilogram live weight gain in Naira of the rabbits that received diets that contained CRETSM were significantly ($p<0.05$) lower than that of the rabbits that were fed control diet. The values were 320, 316, 301, 298, 278 and 318 Naira for the control, 20%, 40%, 60% 80% and 100% CRETSM diets respectively.

The nutrient digestibility of the rabbits is presented in Table 4. No significant ($p>0.05$) difference was observed in the digestibility of dry matter, crude fiber, ether extract and nitrogen free extract. However, digestibility of crude protein was significantly ($p<0.05$) depressed at 100% substitution level.

The organ and carcass characteristics of the rabbits fed varying proportion of CRETSM in replacement for fish meal is shown in Table 5. Live weight, eviscerated weight, and carcass weight of the rabbits that had 0, 20, 40, 60 and 80 percent fish meal in their diets replaced with CRETSM were comparable but were significantly ($p<0.05$) higher than the value obtained for those fed only fish meal as animal protein source. No significant ($p>0.05$) difference was observed in the carcass yield and the weights of liver, kidneys, hearts, lung, spleen and abdominal fat.

Discussion

The protein content of CRETSM used in this study is close to that of fish meal. This implies that CRETSM is a potential animal protein source for livestock animals and fish. The protein content of the CRETSM used in this study is lower than that of Alikwe *et al*. (2005). This could be due to scraping method or the age of the animals from which the scraping was collected. The value was however comparable to that reported by Bawala *et al*, 2007 and Isah and Babayemi, 2010.

The fact that there was no difference in the weight gain of the rabbits fed up to 80% CRETSM and the control diet suggests that CRETSM can replace up to 80% fish meal in growing rabbit diet. Earlier report by Isa and Babayemi (2010) showed that goats fed rumen epithelial tissue scrapings had similar performance with those fed groundnut cake as source of protein. Depression that was observed in the weight gain when fish meal was completely replaced with CRETSM can be attributed to the slight difference observed in protein content compared with that of fish meal and lower digestibility of CRETSM protein compared to that of fish meal. Meat meal and meat and bone meal are known to be inferior to fish meal (FAO, 2012). Furthermore, rumen epithelial scrapings consists mainly of papillae layer which

consists of a central core of densely packed collagen fibres surrounded by stratified epithelium similar to the papillary bodies in skin. However, this observation contradicts the findings of Handa *et al.* (1996) who observed no significant difference in the weight gain of rabbits fed extruded hatchery waste in replacement for fish meal. The difference could however be due to better amino acid profile of hatchery waste being an egg by product. The result also contradicts the finding of Isah and Babayemi (2010) who observed that groundnut cake and soybean meal can be completely replaced with CRETSM in the diet of West African Dwarf goat. This difference is however expected since CRETSM is an animal by product with better amino acid profile than groundnut cake and soybean meal which are plant protein sources.

This study showed that feed intake of the rabbits was not affected by substituting CRETSM for fish meal in the diets which indicates that the palatability of the feed was not adversely affected. The poor feed utilization observed in the rabbits fed 100% CRETSM can be attributed to poor protein digestibility observed in the same group which in turn could be due to poor quality of protein in CRETSM compared to fish meal. Also lower value observed in the live weight, eviscerated weight and carcass weight of the rabbits that received diet 6 (100%CRETSM) can be attributed to poor growth occasioned by poor protein digestibility and feed utilization. The non significant effect of the diets on the weights of internal organs indicates that CRETSM does not contain toxic substance.

Conclusion

The results of this study revealed that CRETSM can be used to replace up to 80% fish meal in the diet of growing rabbits without any adverse effect on growth and with lower cost of feeding. However, total replacement of fish meal with CRETSM reduces growth even though it is still economical in terms of cost of production.

Acknowledgement

The authors wish to appreciate Dr Togun V.A. The Farm Director and the entire staff of Teaching and Research Farm Ladoke Akintola University of Technology, Ogbomoso for their technical support during the period of the study.

References:

A. O. A. C. 1990. *Official methods of analysis* 15th ed. Association of Official Analytical Chemist, Washington D.C.

A. O. A. C. 1995. *The official methods of analysis*. Association of Official Analytical Chemists (16th edition). Arlington. A.O.A.C. International.

Adeniji, A. A. 2007. Effect of replacing groundnut cake with maggot meal in the diet of broilers. *International Journal of Poultry Science* 6 (11):822-825.

Aktar, M., Rashid, M., Azam, M. G., Howlider, M. A. R., and Hoque, M.A. 2011. Shrimp waste and marine waste as substitutes of fish meal in broiler diet. *Bangladesh. Journal of Animal Science* 2011. 40 (1-2)*: 18-22.*

Alikwe, P. C. N., Akinsoyinu, A. O., Babatunde, E. B. and Ogunwole, O. A. 2005. The replacement value of rumen epithelial scrapping meal (RESM) for fishmeal in the diets of broilers. *Tropical Journal of Animal Science* Vol. 8 (1): 69-75.

Bawala, T. O. Adegoke, E. O., Ojekunle, A. O., Adu, F. I. and Aina, A. B. 2007. Utilization of cassava peel and rumen epithelial waste diets by West African Dwarf Sheep. *An International Journal of Agricultural Science, Science, Environment Technology*, Series A, Vol. 7 (1): 168-180.

Duangrat Chookird, Chutima Tantikitti, Amornrat Pongdara and Manee Srichanum. 2010. Effect of hemoglobin powder substituted for fishmeal on growth performance, protein digestibility and trypsin gene expression in Litopenaeus vannamei. *Songklanakarin Journal of Science Technology 32 (2): 119-127*.

FAO. 2012. Animal feed resources information system.
http://www.fao.org/ag/AGA/AGAP/FRG/AFRIS/Data/316.htm retrieved on 6/9/2012

Handa, M. C., Sapra, K. L. and Shingari, B. K. 1996. Effect of feeding extruded hatchery waste on the performance of Soviet Chinchilla rabbits. *World Rabbit Science* 4 (2): 89-92.

Ijarotimi, O. S. and Olopade, A. J. 2009. Determination of amino acid content and protein quality of complementary food produced from locally available food materials in Ondo State, Nigeria. *Mal. J. Nutr*. 15 (1):87-95.

Isa, O. A. and Babayemi, O. J. 2010. Nutrient degradability and performance by the West African Dwarf Goat fed rumen epithelium-based diets. *Journal of Science Technology*. Vol. 12: 289-297.

Ogunwole, O. A. 2011. Degradation of organic matter in groundnut cake, *Panicummaximum* and rumen epithelial scraping based diets by West African Dwarf Sheep. *International Journal of Current Research and Review* Vol. 3 (8): 9-16.

Ravindra, V. and Sivakanesan, R. S. 1995. Breadfruit (*Artocarpus Cummunis*) Meal: Nutrient composition and feeding value for Broiler. *J. Sci. Food Agric.* 69: 379-383.

SAS Institute. 1998. SAS User's Guide Statistic 1998 edition. SAS institute, Inc. Cary,North Carolina.

Sathishkumar, A. and Prabakaran, R. 2008. Recycling of Japanese Quail hatchery waste on egg production performance of Quail Breeders. *Tamilnadu J. Veterinary & Animal Sciences* 4 (4) 123-128

Table 1: Gross composition of experimental diets

	Level of CRETSM substitution for fish meal in the diets (%)					
	0 (control)	20	40	60	80	100
Ingredients (%)	(1)	(2)	(3)	(4)	(5)	(6)
Maize	15.0	15.0	15.0	15.0	15.0	15.0
Maize bran	10.0	10.0	10.0	10.0	10.0	10.0
Wheat offal	28.2	28.2	28.2	28.2	28.2	28.2
Palm kernel cake	20.5	20.5	20.5	20.5	20.5	20.5
Soy bean meal	6.0	6.0	6.0	6.0	6.0	6.0
Fish meal	2.0	1.6	1.2	0.8	0.4	0.0
CRETSM	0.0	0.4	0.8	1.2	1.6	2.0
Rice bran	14.0	14.0	14.0	14.0	14.0	14.0
NaCl	0.3	0.3	0.3	0.3	0.3	0.3
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0
Palm kernel oil	1.0	1.0	1.0	1.0	1.0	1.0
Total	100	100	100	100	100	100
Crude protein (%)	16.8	16.7	16.6	16.8	16.7	16.7
Digestible energy(MJ/kg)	9.4	9.4	9.4	9.4	9.3	9.3
Crude fiber (%)	8.2	8.3	8.4	8.5	8.7	9.0

CRETSM = Cattle Rumen Epithelial Tissue Scrapings Meal

Table 2: Chemical composition of cattle rumen epithelial tissue scrapings

Component	CRETSM	Fish meal
Dry matter (%)	88.71	89.46
Crude protein (%)	64.61	65.72
Crude fiber (%)	3.58	0.51
Ether extract (%)	8.20	14.63
Ash (%)	5.60	11.84
Nitrogen free extract (%)	18.01	7.30
Methionine (%)	0.98	1.12
Lysine (%)	3.80	3.51
Calcium (%)	3.07	7.12
Phosphorus (%)	2.20	3.16
Sodium (%)	0.22	0.38
Magnesium (%)	0.27	0.21
Potassium (%)	0.20	0.45
Iron (ppm)	398	190
Copper (ppm)	8.4	8.9
Zinc (ppm)	23.21	63.32
Manganese (ppm)	8.24	12.96

CRETSM = Cattle Rumen Epithelial Tissue Scrapings Meal

Table 3: Performance and economic implication of substituting CRETSM for fish meal in the diets of grower rabbits

	Level of CRETSM substitution for fish meal in the diets (%)						
Parameter	0 (control) (1)	20 (2)	40 (3)	60 (4)	80 (5)	100 (6)	SEM
Initial weight (kg)	0.94	0.94	0.94	0.93	0.94	0.94	0.01
Final weight (kg)	1.75[a]	1.77[a]	1.78[a]	1.77[a]	1.80[a]	1.68[b]	0.06
Total weight gain (kg)	0.81[a]	0.83[a]	0.84[a]	0.85[a]	0.86[a]	0.74[b]	0.07
Daily weight gain (g)	14.4[a]	14.7[a]	15.0[a]	15.1[a]	15.4[a]	13.2[b]	1.1
Total feed intake (kg)	4.64	4.81	4.94	4.98	4.85	4.96	0.38
Daily feed intake (g)	82.1	85.9	88.2	88.9	86.6	88.6	9.0
Feed to gain ratio	5.73[b]	5.80[b]	5.88[b]	5.93[b]	5.64[b]	6.74[a]	0.5
Feed cost/kg (N)	55.8[a]	54.5[b]	51.2[c]	50.9[c]	49.3[d]	47.2[e]	0.9
Feed cost/kg gain (N)	320[a]	316[c]	301[d]	298[e]	278[f]	318[b]	1.5

abcdef: means bearing different superscripts along the same row are significantly different ($p<0.05$); CRETSM = Cattle Rumen Epithelial Tissue Scrapings Meal; N = Naira

Table 4: Nutrient digestibility of grower rabbits fed CRETSM in replacement for fish meal.

	Level of CRETSM substitution for fish meal in the diets (%)						
Parameter (%)	0 (control) (1)	20 (2)	40 (3)	60 (4)	80 (5)	100 (6)	SEM
Dry matter	70.9	71.2	71.0	72.8	72.8	72.4	2.5
Crude protein	74.2[a]	75.1[a]	74.2[a]	75.2[a]	75.3[a]	71.3[b]	1.5
Crude fiber	32.4	32.2	32.0	32.1	32.3	32.4	0.8
Ether extract	72.8	72.3	71.9	72.1	71.8	71.8	2.0
Nitrogen free extract	67.2	68.1	67.8	68.6	69.1	68.5	2.3

ab: means bearing different superscripts along the same row are significantly different ($p<0.05$); CRETSM = Cattle Rumen Epithelial Tissue Scrapings Meal

Table 5: Organ and carcass characteristics of rabbits fed varying levels of CRETSM in substitution for fish meal

Level of CRETSM substitution for fish meal in the diets (%)

Parameter	0 (control) (1)	20 (2)	40 (3)	60 (4)	80 (5)	100 (6)	SEM
Live weight (kg)	1.84[a]	1.88[a]	1.83[a]	1.87[a]	1.86[a]	1.75[b]	0.07
Eviscerated weight (kg)	1.36[a]	1.35[a]	1.34[a]	1.38[a]	1.37[a]	1.20[b]	0.08
Carcass weight (kg)	1.03[a]	1.06[a]	1.05[a]	1.06[a]	1.07[a]	1.00[b]	0.03
**Carcass yield (%)	58.6	59.5	57.8	57.2	57.5	58.5	3.0
**Liver (%)	2.02	2.26	2.07	2.11	2.21	2.18	0.4
**Kidneys (%)	0.51	0.56	0.60	0.54	0.61	0.54	0.3
**Heart (%)	0.21	0.23	0.24	0.23	0.21	0.22	0.05
**Lung (%)	0.52	0.56	0.47	0.46	0.44	0.46	0.2
**Spleen (%)	0.04	0.05	0.04	0.05	0.04	0.03	0.03
**Abdominal fat (%)	1.65	1.33	1.59	1.32	1.67	1.37	0.8

ab: means bearing different superscripts along the same row are significantly different ($p<0.05$); CRETSM = Cattle Rumen Epithelial Tissue Scrapings Meal; ** Percent of live weight: