A COMPARATIVE is ANALYSIS ON HEAVY METALS IN FARMED FISH FROM AKAKAI FISH POND AND WILD NILE TILAPIA FROM LALLE LANDING SITE IN SOROTI DISTRICT TESO SUB-REGION

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APM3206

A DESERTATION SUBMITTED TO THE FACULTY OF AGRICULTURE AND ANIMAL SCIENCES IN PARTIAL FULFILLMENT FOR THE AWARD OF A BACHELOR'S DEGREE IN ANIMAL PRODUCTION AND MANAGEMENT OF BUSITEMA UNIVERSITY

September, 2022

ABSTRACT

Globally, both natural water bodies and aquaculture systems are being severely contaminated by heavy metals due to rising anthropogenic activities. Fish living in aquatic environments can easily accumulate metals in their bodies, which can then be transferred to consumers and put them at risk. This study assessed three heavy metals (lead, cadmium and arsenic) from edible muscles of Oreochromis niloticus from L. kyoga at Lalle landing site located in Lalle Parish, Kamuda Sub county and fish ponds owned by Paradise Integrated Fish Farmers (PIFF**)** in Akakai village in Arapai sub-county in Soroti district. Physicochemical parameters of water in the study area were analysed. Temperatures ranged between 27.8–29.2˚C, pH: 7.8–8.61. The levels of heavy metals in the tissues of Oreochromis niloticus from t farmed and wild were determined using Atomic Absorption Spectrometry (AAS). The maximum average concentrations of heavy metals observed in Nile tilapia fish tissues from both the wild and farmed in Soroti district were as follows As (2.923 µg/g) > Pb (0.118 µg/g) > Cd (0.0072 µg/g). The concentrations of the metals (Pb, Cd, and As) were below the recommended limit by WHO and FAO which are Cd (0.5 µg/g), As (10 µg/g) and Pb (0.5 µg/g). The mean differences between sample from farmed and the wild Oreochromis niloticus were not statistically significant and according to the results, eating tilapia from Soroti district both farmed and wild posed no risk to human health.

DECLARATION

I hereby declare that, this work is truly my original work and it has never been submitted in any institution for any academic award.

Student

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Signature.....

Date...12/06/2023.....

This research proposal thesis is submitted by the approval of

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LIST ABBREVIATIONS

AAS:……Atomic Absorption Spectrum

O.P……...Organophosphates

Dr:…….Doctor

Cu: …….…….…. Copper

Pb: …… Lead

Zn: …… Zinc

Ni: …… Nickel

Cd: ……... Cadmium

As: …… Arsenic

Fe: ……. Iron

WHO: …….. World Health Organization

FAO: …… Food and Agriculture Organization

Ca: …… Calcium

H NO_3: …….…….Nitric Acid

AAS: …… Atomic Absorption Spectrometry

SSA ……..Sub Saharan Africa

DEDICATION

This work is dedicated to administration BUSITEMA UNIVERSITY ARAPAI CAMPUS my mom Mrs. NAMAGANDA HAJALA, my dad Mr. KULOBA DAVID my brothers Mr. MAFABI ISSA WALIYU & Mr. MAFABI HAMISI who have supported and guided me not only academically but also in all aspects of life and are still supporting me up now when am at the university. I also dedicate it to my sibling as a sign of encouragement for academic enhancement.

ACKNOWLEDGEMENT

First and foremost, i do extend my thanks to the almighty God for keeping me through up to this time and giving me good health.

I would like to also acknowledge the administration of BUAC more especially the department of animal production and management and thanking the lecturers for scheduling this research program early within the first semester of the third year.

I would like to acknowledge the contribution of the following people my mum Mrs. Namaganda Hajala, and to all my brothers Mr. Mafabi Hamisi, Mr. Mafabi Issa Waliyu Mr. Wapoyi Karim and Mr. Wasikye Paul for supporting me both spiritually and financially..

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CHAPTER ONE: INTRODUCTION

1.1. Background

Aquaculture is a fast-growing sector that contributes significantly to food security,(Verreth, n.d.) Accounting for almost 50 percent of the world's food fish and provides an important source of high-quality protein and omega 3 fatty acids that help to maintain cardiovascular health by playing a major role in the regulation of blood clotting and vessel constriction, it also leads to economic development.(Intake, 2016) In 2018, the estimated the global human consumption of fish to be 156 million tones. By 2005, one quarter of wild fish stocks were underexploited, half fully exploited and the rest had been overexploited or depleted (Hamada et al., 2018). The decline in wild fish stocks contributes to the need for a growing aquaculture sector for protection of food security (Hamada et al., 2018). Since 1970, world aquaculture has grown by an average of 7.5% per year. The fastest growth has been in Africa and Asia, which have recorded double-digit growth in the past 20 years. In 2018, total fish production from both fisheries and aquaculture reached 179 million tones, and aquaculture contributed 46% (82 million tones) of the total production. Apart from being a source of protein, essential fatty acids, minerals and vitamins, fish also serve as a source of income for people in developing countries. In 2018, the estimated World fish trade at about USD 400 billion, with USD 250 billion coming from aquaculture production. Africa currently contributes about 7% to the total global fish production. (Hamada et al., 2018)

In Uganda, annual fish production trends and economic value of fish catch production as of 2019 in lakes Albert (335,000 tonnes valued at 700 bn), Edward, George and the Kazinga Channel (6,630 tonnes valued at ~ 47 bn) have been generated.(Annual & Report, 2020) There are estimated 20000 ponds throughout the country with an average surface area of 500m2 per pond. Production ranges between 1500kg per hectare per year for subsistence farmers to 15000kg per hectare per year for emerging commercial fish farmers

The American Heart Association recommended consumption of fish at least twice per week in order to reach the daily intake of omega-3 fatty acids.(Magna et al., 2021) However, fish normally accumulate heavy metals from food, water, and sediments and this is a good indicator of heavy metals contamination in water(Bawuro et al., 2018).

The presence of toxic heavy metals in fish can invalidate their beneficial effects. Several unfavorable effects of heavy metals to human health have been known for long time. (Hamada et al., 2018) This

References

Abdalla, A., Bashir, N. H. H., Abdelbagi, A. O., Osman, Y., & Mohamed, H. (2019). *HEAVY METALS CONCENTRATIONS IN NILE TILAPIA FISH (OREOCHROMIS NILOTICUS) IN DONGOLA AND MEROWE , NORTHERN STATE , SUDAN RESEARCH ARTICLE HEAVY METALS CONCENTRATIONS IN NILE TILAPIA FISH (OREOCHROMIS NILOTICUS)*. *April*. https://doi.org/10.24941/ijcr.34660.03.2019

Achparaki, M., Thessalonikeos, E., Tsoukali, H., Mastrogianni, O., Zaggelidou, E., Chatzinikolaou, F., Vasilliades, N., & Raikos, N. (n.d.). *Heavy metals toxicity* .

Annual, D., & Report, P. (2020). *THE REPUBLIC OF UGANDA MINISTRY OF AGRICULTURE , ANIMAL INDUSTRY AND FISHERIES*. *October*.

Bawuro, A. A., Voegborlo, R. B., & Adimado, A. A. (2018). Bioaccumulation of Heavy Metals in Some Tissues of Fish in Lake Geriyo, Adamawa State, Nigeria. *Journal of Environmental and Public Health*, *2018*. https://doi.org/10.1155/2018/1854892

Beaty, R. D. (1978). *Concepts, Instrumentation and Techniques in Atomic Absorption Spectrometry*. 49.

Cengiz, M. F., Certel, M., & Göçmen, H. (2006). Residue contents of DDVP (Dichlorvos) and diazinon applied on cucumbers grown in greenhouses and their reduction by duration of a pre-harvest interval and post-harvest culinary applications. *Food Chemistry*, *98*(1), 127–135. https://doi.org/10.1016/j.foodchem.2005.05.064

Dallinger, A. R., Prosi, F., Segner, H., Back, H., Dallinger, R., Prosi, F., Segner, H., & Back, H. (1987). *Contaminated Food and Uptake of Heavy Metals by Fish : A Review and a Proposal for Further Research Published by : Springer in cooperation with International Associati*on *for Ecology Stable URL : https://www.jstor.org/stable/4218334 Contaminated food and u*. *73*(1), 91–98.

Gerenfes, D., Teju, E., Agricultural, K., Agriculture, H., & Ababa, A. (2018). *Determination of Some Selected Heavy Metals in Water , Oreochromis niloticus and Labeobarbus intermedius Samples from Abaya and Chamo Lakes*. *8*(21), 85–95.

Gerenfes, D., Teju, E., Agricultural, K., Agriculture, H., & Ababa, A. (2019). Determination of Some Selected Heavy Metals in Water, Oreochromis niloticus and Labeobarbus intermedius Samples from Abaya and Chamo Lakes. *Food Science and Quality Management*, *8*(21), 85–95. https://doi.org/10.7176/fsqm/83-05

Godwill, E. A., Nwalo, F., & Unachukwu, M. (2019). *We are IntechOpen , the world ' s leading publisher of Open Access books Built by scientists , for scientists*. *June*. https://doi.org/10.5772/intechopen.82511

Hahladakis, J. (2015). *Standard of the permissible limits of toxic heavy metals and arsenic in fish and sea water and sediment?*

Hamada, M. G., Elbayoumi, Z. H., Khader, R. A., & Elbagory, A. R. M. (2018). *Assessment of Heavy Metal Concentration in Fish Meat of Wild and Farmed Nile Tilapia (Oreochromis Niloticus),*

Egypt. *57*(April), 30–37. https://doi.org/10.5455/ajvs.295019

Hyuha, T., Ekere, W., Egna, H., & Molnar, J. J. (2017). *Social and economic performance of tilapia farming in uganda*. *October*.

Intake, M. (2016). *Determination of Heavy Metals in Tilapia using Various Digestion Methods Determination of Heavy Metals in Tilapia using Various Digestion Methods Department of Chemistry , Faculty of Science , University of Colombo , Sri Lanka Faculty of Applied Sciences . May 2018*.

Jaishankar, M., Tseten, T., Anbalagan, N., Mathew, B. B., & Beeregowda, K. N. (2014). *Toxicity , mechanism and health effects of some heavy metals*. *7*(2), 60–72. https://doi.org/10.2478/intox-2014-0009

Kundu, G. K., Alauddin, M., & Akter, M. S. (2017). *Metal contamination of commercial fish feed and quality aspects of farmed tilapia (Oreochromis niloticus) in Bangladesh*. *3*(1), 345–353.

Li, H., Shi, A., Li, M., & Zhang, X. (2013). Effect of pH, Temperature, Dissolved Oxygen, and Flow Rate of Overlying Water on Heavy Metals Release from Storm Sewer Sediments. *Journal of Chemistry*, *2013*, 11. https://doi.org/10.1155/2013/434012

Life, T. (2014). *2 2 2 1*. *25*(2), 21–39.

MAAIF. (2020). *Aquaculture Training Manual for Extension Agents in Uganda*. *785*, 246.

Magna, E. K., Koranteng, S. S., Donkor, A., & Gordon, C. (2021). Health Risk Assessment and Levels of Heavy Metals in Farmed Nile Tilapia (Oreochromis niloticus) from the Volta Basin of Ghana. *Journal of Chemistry*, *2021*. https://doi.org/10.1155/2021/2273327

Mahurpawar, M. (2015). *Effects of heavy metals on human health*. *0530*.

Makori, A. J., Abuom, P. O., Kapiyo, R., Anyona, D. N., & Dida, G. O. (2017). Effects of water physico-chemical parameters on tilapia (Oreochromis niloticus) growth in earthen ponds in Teso North Sub-County, Busia County. *Fisheries and Aquatic Sciences*, *20*(1), 1–10. https://doi.org/10.1186/s41240-017-0075-7

Mannzhi, M. P., Edokpayi, J. N., Durowoju, O. S., Gumbo, J., & Odiyo, J. O. (2021). Assessment of selected trace metals in fish feeds, pond water and edible muscles of Oreochromis mossambicus and the evaluation of human health risk associated with its consumption in Vhembe district of Limpopo Province, South Africa. *Toxicology Reports*, *8*, 705–717. https://doi.org/10.1016/j.toxrep.2021.03.018

MoLHUD. (2017). Ministry of Lands , Housing and Urban Development. *The Draft National Land Policy*, *Idc*, 91p. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fmlhud.go.ug%2Fwp-content%2Fuploads%2F2019%2F07%2FNational-Urban-Policy-2017-printed-copy.pdf&clen=8785404&chunk=true

Mustapha, M. K., & Atolagbe, S. D. (n.d.). *(No Title)*. https://doi.org/10.1186/s41936-018-0061-3

Ndayisenga, J. D., & Dusabe, S. (2022). Ponds' Water Quality Analysis and Impact of Heavy Metals on Fishes' Body. *Journal of Sustainability and Environmental Management*, *1*(2), 62–72. https://doi.org/10.3126/josem.v1i2.45334

Nivelle, R. I., Gennotte, V., Jules Kembolo Kalala, E., Bich Ngoc, N., MullerID, M., Mé lard, C., Rougeot, C., & Loor, J. J. (2019). *Temperature preference of Nile tilapia (Oreochromis niloticus) juveniles induces spontaneous sex reversal*. https://doi.org/10.1371/journal.pone.0212504

Openjuru, G. L., & Ph, D. (2019). *Makerere university makerere university*. *June*, 540009.

Outa, N. O., Kitaka, N., & Njiru, J. M. (2014). Some aspects of the feeding ecology of Nile tilapia , Oreochromis niloticus in Lake Naivasha , Kenya. *International Journal of Fisheries and Aquatic Studies*, *2*(2), 1–8.

Ranasinghe, P., Weerasinghe, S., Kaumal, M., Agarin, C. J. M., Mascareñas, D. R., Nolos, R., Chan, E., & Senoro, D. B. (2016). Determination of Heavy Metals in Tilapia using Various Digestion Methods Determination of Heavy Metals in Tilapia using Various Digestion Methods Department of Chemistry , Faculty of Science , University of Colombo , Sri Lanka Faculty of Applied Sciences. *International Journal of Scientific Research and Innovative Technology*, *3*(6), 71. https://www.mdpi.com/2305-6304/9/4/71/htm%0Ahttps://www.mdpi.com/2305-6304/9/4/71

Republic, T. H. E. (2016). *TESO INVESTMENT Soroti Flying School*. 1–28.

Siddiqui, I., Sirajuddin, S., Khan, F. A., Bhutto, S., & Tahir, M. (2011). *Determination of some heavy metals in hen eggs using ICP-AES technique*. *44*(4), 133–136.

Simukoko, C. K., Mwakalapa, E. B., Bwalya, P., Muzandu, K., Berg, V., Mutoloki, S., & Polder, A. (2022). Food Additives & Contaminants : Part A Assessment of heavy metals in wild and farmed tilapia (Oreochromis niloticus) on Lake Kariba , Zambia : implications for human and fish health. *Food Additives & Contaminants: Part A*, *39*(1), 74–91. https://doi.org/10.1080/19440049.2021.1975830

Simukoko, C. K., Mwakalapa, E. B., Bwalya, P., Muzandu, K., Berg, V., Mutoloki, S., Polder, A., & Lyche, J. L. (2022). Assessment of heavy metals in wild and farmed tilapia (Oreochromis niloticus) on Lake Kariba, Zambia: implications for human and fish health. *Food Additives and Contaminants - Part A Chemistry, Analysis, Control, Exposure and Risk Assessment*, *39*(1), 74–91. https://doi.org/10.1080/19440049.2021.1975830

Suganya, T., Senthilkumar, S., Deepa, K., Muralidharan, J., Sasikumar, P., & Muthusamy, N. (2016). *Metal Toxicosis in Poultry – A Review*. *5*(2), 515–524.

Sujatha, K., Durairajsinghu, V., & Silambarasan, K. (2016). *Determination of some heavy metals in fish , water and sediments from bay of Bengal DETERMINATION OF SOME HEAVY METALS IN FISH , WATER AND SEDIMENTS FROM BAY OF BENGAL*. *August 2017*.

Sultana, N., Moinul, A. K. M., Meaze, H., Hossain, S., Khandaker, U., Kamal, M., & Deb, N. (2020). The presence of toxic metals in popular farmed fi sh species and estimation of health risks through their consumption. *Physics Open*, *5*(August), 100052. https://doi.org/10.1016/j.physo.2020.100052

Tadiboyina, R., & Ptsrk, P. R. (2016). Trace analysis of heavy metals in ground waters of Vijayawada industrial area. *International Journal of Environmental and Science Education*, *11*(10), 3215–3229.

Teso Investment Profile. (2016).

Uganda Population (2022) - Worldometer. (n.d.). Retrieved September 11, 2022, from https://www.worldometers.info/world-population/uganda-population/

Verreth, J. (n.d.). *The effect of recirculating aquaculture systems on the concentrations of heavy metals in culture water and tissu ...* https://doi.org/10.1016/j.foodchem.2010.11.108

Yabe, J., Ishizuka, M., & Umemura, T. (2020). *Current Levels of Heavy Metal Pollution in Africa*. *October 2010*. https://doi.org/10.1292/jvms.10-0058