



SJMLS - 5 (4) - 004

Pathologic Improvements by Some Dietary Plants in an Animal Model of CarcinogenesisFamiyesin T.O.¹, Appah, J.², Egbe, N.³, Bello, Z.M.⁴, Chukwuebuka, U.I.⁵ and Abubakar, S.D.^{4,6*}

Medical Laboratory Science Department, Shehu Idris College of Health Science and Technology, Makarfi, Nigeria¹, Department of Biological Sciences, Nigeria Defence Academy, Kaduna, Nigeria², Department of Biotechnology, Nigeria Defence Academy, Kaduna, Nigeria³, Department of Medical Laboratory Science, College of Medical Sciences, Ahmadu Bello University, Zaria, Nigeria⁴, Department of Veterinary Pathology, University of Nigeria, Nsukka, Nigeria⁵, Department of Molecular Pathology, Research Institute for Biomedical Science, Tokyo University of Science, Japan⁶.

Author for Correspondence*: dsabubakar@abu.edu.ng/sharaf501@yahoo.co.uk

Abstract

Cancer morbidity and mortality is on the rise worldwide. Despite advances in medical sciences, its management is costly, and access is not available to the poorest individuals particularly those in low income developing countries. The aim of this study is to assess the potential of some commonly consumed plants for their anti-neoplastic potential using an animal model of cancer. We focus on 3 commonly consumed plants - *Amaranthus hybridus*, *Basella alba* and *Talinum triangulare*. Chemical carcinogenesis was induced in female Wistar rats using the well-established 7, 12-Dimethylbenz[a]anthracene (DMBA) method and treated with aqueous extracts of the leaves of these plants. Analysis of the hepatic enzymes showed improvement of hepatic damage. This was confirmed by histological examination of the liver. Histologic examination of the colon and mammary glands were also done to confirm these observations. Moreover, the plants also contained bioactive metabolites such as tannins, saponins and other alkaloids. The plants showed an improvement in histological features in the organs of interest. This study indicates the potential role of these plants in the resolution of cellular injury or in the suppression of neoplastic cells. Their incorporation in the diet of cancer patients is recommended.

Keywords: Cancer, DMBA, dietary plants, complementary medicine, *Amaranthus hybridus*, *Basella alba*, *Talinum triangulare*

Introduction

Cancers are heterogeneous multicellular entities containing cells of multiple lineages whose

interactions with one another, the extracellular matrix (ECM), and soluble molecules in their vicinity are dynamic and favour cell proliferation, movement, differentiation, and ECM metabolism, while simultaneously restricting cell death, stationary polarized growth, and ECM stability (Tlsty and Coussens, 2006). Within a 10-year period, the global incidence has risen from 18.3 million in 2007 to 24.5 million in 2017 (GBODCC, 2019) and has accounted for about 17% of all deaths in 2017 (Roth et al., 2017). The incidence and mortality vary from country to country. However, the World Health Organization (WHO) (WHO, 2020) estimates that cancer is the first or second leading cause of death in 91 of 172 countries, and third or fourth in an additional 22 countries signifying a huge public health menace. Breast cancer and colon cancer are among the top 5 in terms of incidence and mortality in every region of the world (Bray et al., 2018).

Depending on the location or type of cancer, the management strategies include surgery, chemotherapy, immunotherapy, radiation therapy, hormonal therapy, targeted therapy, stem cell transplant, precision medicine and palliative care (National Cancer Institute, 2020). These management strategies have seen significant advancements and sophistication yet, unaffordable for the poorest individuals in the world. Herbal remedies have been reported occasionally with some promise (Bernstein and Grasso, 2001). The role of diet (Zhang et al., 2020a) and lifestyle changes (Zhang et al., 2020b) is gaining its well-deserved attention and critical appraisal, yet, local practices are often ignored.



7, 12-Dimethylbenz[a]anthracene (DMBA) is an organ-specific laboratory carcinogen and an immunosuppressor (Medina *et al.*, 1980). It acts at several sites, including skin, mammary gland, and oral cavity as a powerful initiating agent and hence, a potent carcinogenic chemical. DMBA is a commonly used and a well-established agent in numerous research studies on tumour in general and cancer in particular (Frenkel *et al.*, 1995).

Sub-Saharan Africa (Nigeria inclusive) is blessed with natural vegetation and a lot of them is used as food. Having recognized that several plants have shown possible anti-inflammatory (Abubakar *et al.*, 2017) and anti-cancer properties (Engdal and Nilsen 2008, Bernstein and Grasso 2001), an evaluation of edible plants or vegetable becomes necessary as a bulk of the population living in this area are resource deprived and standard medical practices are too costly for them. A lot of people resort to herbal remedies.

Using Wistar rats, this study aims to check the possible anti-neoplastic properties of 3 commonly consumed vegetables in Nigeria in an animal model of cancer. The 3 vegetables included in this study are the red spinach or African spinach - *Amaranthus hybridus* (AH), Ceylon spinach - *Basella alba* (BA) and water leaf - *Talinum triangulare* (TT). This manuscript will also provide much needed background data for the potential of these plants in cancer patients.

Materials and Methods

Animal Management

30 female Wistar rats weighing between 100 to 150 g and 8-12 weeks' old obtained from Biological Science Department, Nigeria Defence Academy, Kaduna were used for this study. The rats were kept in steel metal cages under standard conditions (26±2°C, 12 hours' light/dark cycle) and fed with commercially formulated feed (Vital Feed Nig. Ltd.) and clean water ad libitum. Cages and litter were cleaned regularly by the staff. All methods involving the use of laboratory animals in this study complied with the regulatory principles for research involving animals in the above-named institution and as enshrined by the declaration of Helsinki in the care and use of animals. Animals were acclimatized for two weeks prior to the beginning of experiments.

Plant Collection and Extraction

Leaves of *Amaranthus hybridus* (AH), *Basella alba* (BA) and *Talinum triangulare* (TT) were obtained from commercial sources (Central Market, Kaduna). The plants were authenticated by the Chief taxonomist in the institution and deposited with ID – NDA/PGS/0027-9. Crude extraction was done by standard methods (Bako *et al.*, 2010). Briefly, the leaves were shade dried for two weeks then grounded into fine powder using pestle and mortar. Distilled water was used as diluents for the extraction using Soxhlet apparatus. 100g of powdered leaves was constituted in 1000mL of distilled water for 24 hours and then filtered. Aqueous extraction was used in order to mimic culinary practices.

Preliminary Qualitative Phytochemical Analysis

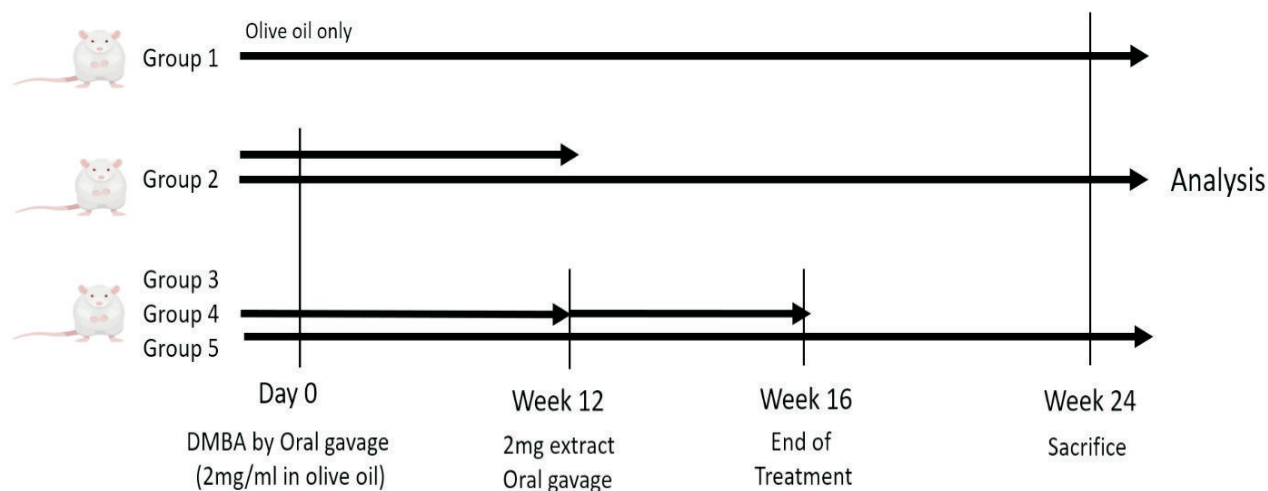
To identify bioactive components of the extracts, qualitative phytochemical screening was done using standard methods (Okwu and Omodamiro 2005, Odebiyi and Sofowora 1979). Tests were carried out for Saponins, Tannins, Alkaloids (Wagner, Mayer and Dragendoff's Test), Flavonoids, and Cardiac Glycosides using standard methods (Khalid *et al.*, 2018; Sheela 2013; Bako *et al.*, 2010, Okwu and Omodamiro 2005, Odebiyi and Sofowora 1979).

Induction of Chemical Carcinogenesis

DMBA (Sigma Aldrich, Germany, >95% purity) was re-constituted in olive oil at a concentration of 2mg/ml. 1ml of the solution was administered to the animals weekly for 12 weeks via oral gavage.

Experimental Design

Thirty (30) Wistar rats were distributed randomly (by balloting) into five different experimental groups (Group 1-5) as depicted in Figure 1. Group 1 serves as a control group and received only olive oil. Group 2 serves as the untreated group and was administered DMBA. Groups 3-5 were administered DMBA and extracts of AH, BA and TT respectively via oral gavage for 4 weeks after DMBA cessation. All experimental animals were sacrificed 8 weeks after cessation of treatment.

FIGURE 1 – EXPERIMENTAL PLAN

Biochemical Assay for Liver Function Test

Blood samples were collected from all anaesthetized animals into appropriate tubes and serum was obtained by centrifugation at 5000rpm for 10 minutes. Serum samples were analyzed using Selectra Pro S Auto analyzer (ELITech, 6003-500) using the prescribed kits for Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline Phosphates (ALP). All parameters were determined colorimetrically according to Reitman and Frankel methods (Frankel *et al.*, 1995).

Histopathology Studies

Animals were humanely sacrificed by cervical dislocation after being anaesthetized with chloroform (Sigma Aldrich, Germany). A single animal was used from each group. The liver, colon and mammary gland were excised, rinsed in buffered saline and fixed in buffered formal saline for 48 hours. Tissues were dehydrated in ascending grades of alcohol (50%, 70%, 90% and 100%) for 3 hours and cleared in two changes of xylene (clearing agent) for 3hours. The tissues were then infiltrated and embedded in paraffin wax (Sigma Aldrich), cut with a rotary microtome (Leica, RM-2125 RTS) and stained using Haematoxylin and eosin (H&E) staining technique.

Statistical Analysis

Data obtained were expressed as the mean \pm SEM. After normality test (Kolmogorov-Smirnov) was done, t test was used to compare between 2 groups while Analysis of Variance (ANOVA) and Least Significant Difference was used for difference among groups. Statistical Package for Social Science (SPSS 20) was used to analyse the data. The cut-off value was set at $p < 0.05$ and $p < 0.01$ and was considered statistically significant.

Results

Phytochemical Screening of Plant bioactive metabolites

The results of phytochemical screening of AH, BA and TT are presented in Table 1. The findings revealed that saponins and tannins were present in leaves of the three plants. Flavonoids were detected in TT leaf extracts only. The presence of glycosides was observed in leaves of TT and AH while BA was deficient of it. For the presence of alkaloids, Dragendoff test showed positive outcomes for all three plants leaf extracts under study while Mayer's and Wagner's tests showed negative response for BA but positive for the other 2 (AH and TT).

Table 1: Phytochemicals (Bioactive Compounds) present in various plant extracts

Bioactive Compounds	<i>Amaranthus hybridus</i>	<i>Basella alba</i>	<i>Talinum triangulare</i>
Saponins	+	+	+
Tannis	+	+	+
Flavonoids	-	-	+
Glycosides	+	-	+
Alkaloids			
Mayer's Test	+	-	+
Dragendoff Test	+	+	+
Wagner's Test	+	-	+
Legend:	Negative (-)	Positive (+)	

Biochemical Analysis of Hepatic Enzymes

Table 2 presents the mean values of biochemical parameter variations in BA, TT and AH. The result thus shows that, there was a significant difference between the mean of alkaline phosphates (ALP) and alanine aminotransferase (ALT) levels in all plants. However, there was no significant difference between the mean of aspartate aminotransferase (AST) level in all the plants at $p \geq .001$ and $p \geq 0.05$.

Table 2: Mean and Standard Deviation of the various leaf Extracts on the Liver Enzyme

STUDY GROUP	AST	ALT	ALP
Group 1 (Control)	0.33 ± 0.006	43.67 ± 3.512	51.00 ± 1.732
Group 2 (Untreated)*	58.33 ± 4.041	42.00 ± 1.000	56.00 ± 2.646
Group 3 (<i>A. hybridus</i>) *	0.67 ± 0.006	1.65 ± 0.040	3.67 ± 0.577
Group 4 (<i>B. alba</i>) *	1.33 ± 0.006	7.00 ± 0.872	46.33 ± 2.082
Group 5 (<i>T. triangularia</i>) *	0.31 ± 0.006	20.67 ± 0.557	52.67 ± 2.517

*Statistically significant compared to Control
 Statistically Significant using two-way ANOVA

Effects of the Extracts on Hepatic Histology

Control animals show normal histology with virtually intact central vein and healthy-looking hepatocytes. As expected, untreated animals (group 2) show marked congestion in the central portal sinusoids veins. Hepatocytes exhibits hyperchromasia with extensive foci of necrosis. Administration of the extracts showed markedly less pathological features than in untreated animals. Animals administered with AH shows

slight congestion in the portal veins with little centrilobular necrosis. Animals administered with BA shows no congestion in the portal vein but little necrosis around some hepatocytes. Animals administered with TT shows some congestion in the central vein with little necrosis around some hepatocytes. Photomicrographs are shown in Figure 2. This shows a reduction in pathological features upon extract administration.

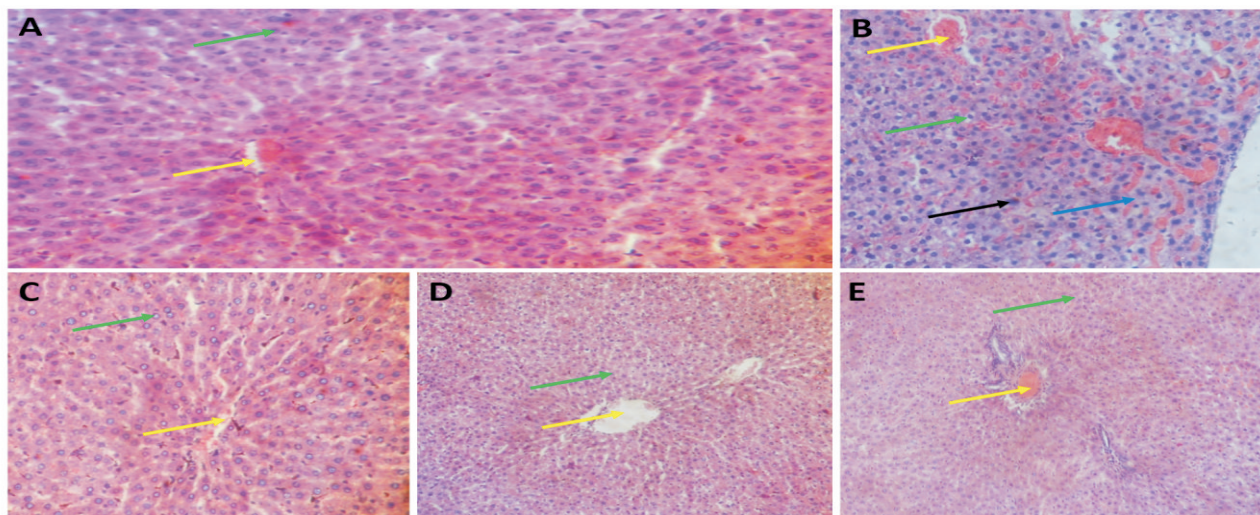


Figure 2: Photomicrographs showing liver of control (A), untreated (B) and extract (AH, BA and TT) administered (C, D and E respectively) animals. The centrilobular vein (yellow arrows) and hepatocytes (green arrow) are shown. Hyperchromasia and necrotic foci are shown with black arrow and blue arrow respectively. (H&E)

Effects of the Extracts on Colon Histology

Control animals show viable and abundant goblet cells (yellow arrows) with intact villi and mucosal folds (green arrows). Unsurprisingly, untreated controls showed massive necrosis, distortion of mucosal folds and lost or even absent goblet cells. There is massive inflammatory cellular infiltration (black arrows) in all the tissue layers and hyperchromatic cells (blue arrow) in the mucosa. There was observable reduction in pathologic severity in animals administered with the extracts. Animals

given AH show intact mucus glands; however, villi of the mucosa folds show slight necrosis and some inflammatory cell infiltration in the mucosa. Animals receiving BA also shows similar features as above but with more little infiltrates in the sub mucosa and muscularis layer. Animals receiving TT also showed similar features but had more infiltrates in the sub mucosa and muscularis layer. The photomicrographs are shown in figure 3. Compared to untreated animals, the extracts showed better histological features.

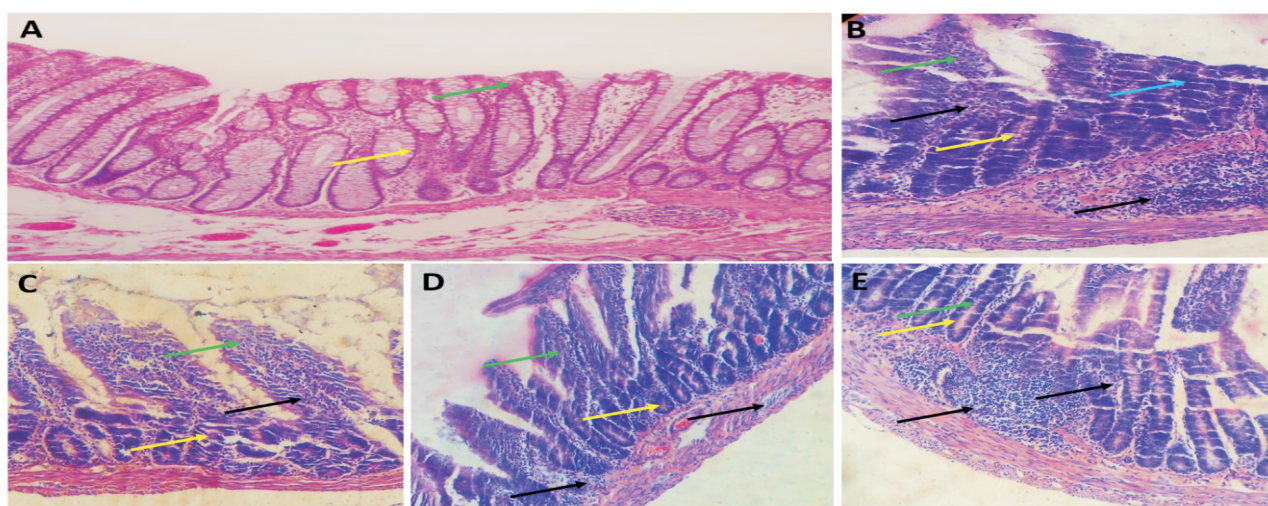


Figure 3: Photomicrographs showing colon of control (A), untreated (B) and extract (AH, BA and TT) administered (C, D and E respectively) animals. Changes in the goblet cells (yellow arrow) and mucosal folds (green arrow) are shown. Inflammatory cellular infiltrates are shown with black arrow and hyperchromatic cells highlighted with blue arrow (H&E).

Effects of the Extracts on Mammary Tissue Histology

Control animals show normal mammary tissue architecture with normal clear acini (yellow arrow) and muscle layers (green arrow). Predictably, untreated animals show congested and hyperplastic acini, hypertrophied muscles and proliferation of cellular proliferation into nearby ductules. Animals receiving the extracts however showed better histological features. Those receiving AH only showed mild

hyperplasia in the acini but with normal muscle layers. Animals receiving BA also showed collapsed hyperplastic acini but muscle layers are normal. Those receiving TT on the other hand showed hyperplastic, unremarkable acini with some muscular hypertrophy. Photomicrographs are shown in Figure 4. Compared to untreated animals, the histological features seen in extract administered animals suggest an improvement in the resolution of the pathology.

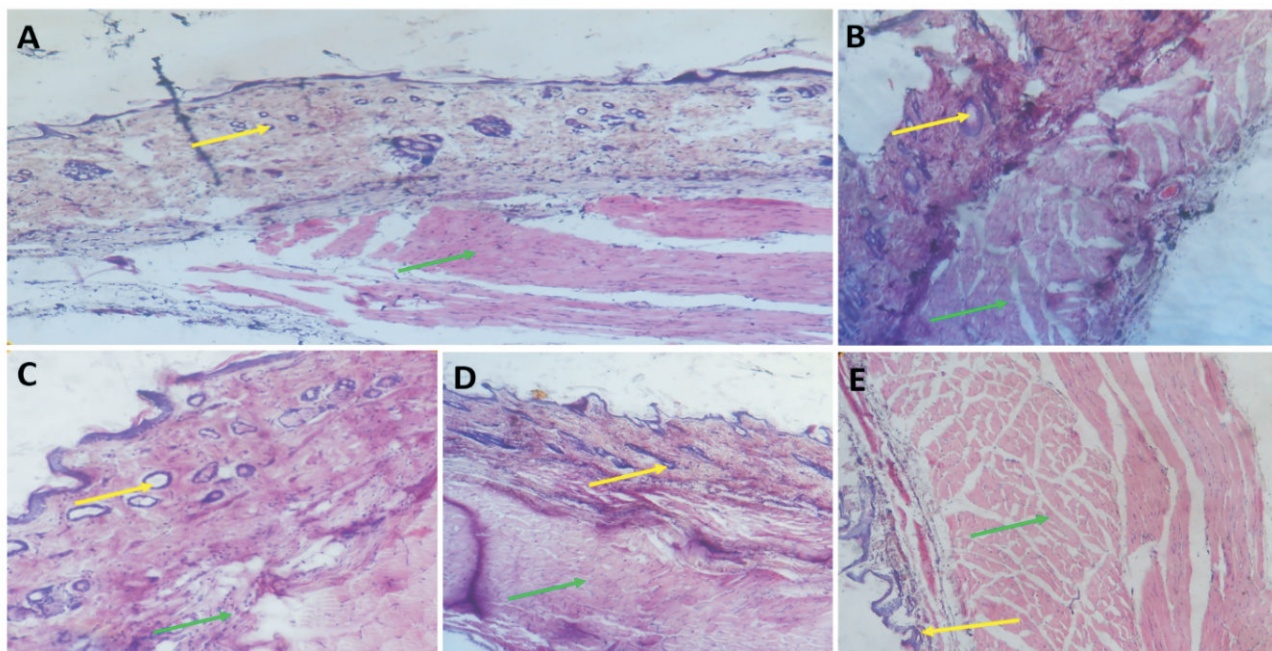


Figure 4: Photomicrographs showing mammary tissue of control (A), untreated (B) and extract (AH, BA and TT) administered (C, D and E respectively) animals. Changes in the mammary acini (yellow arrow) and adjoining muscle layer (green arrow) are highlighted. (H&E).

Discussion

In determining the bioactive component of vegetable plant, phytochemical analysis is very important, most especially those being used as medications and those under consideration or investigation for medicinal purposes. The findings of this study revealed the presence of saponins, flavonoids, glycosides, tannins and alkaloids in TT which was supported by an earlier paper (Aja *et al.*, 2010). AH revealed the presence of saponins, glycosides, tannins and alkaloids which is in agreement with an earlier report (Akubugwo *et al.*, 2007); while BA revealed the presence of saponins, tannins and alkaloids which is partially similar with another research (Azad *et al.*, 2013). Plants containing saponins, flavonoids, glycosides, tannins and alkaloids shows high potential of being

medicinal (Sankhalkar and Vernekar, 2016) and hence, their dietary values deserve to be recognized.

The commonest enzymes used as pointers of hepatocellular damage are the transaminase enzymes: Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphatase (ALP). These enzymes were examined in all the experimental groups. It is well known that injury to the liver leads to increase in their activities in the blood (Abdelhalim and Moussa, 2013). Increase in liver enzyme actions is roughly proportionate to the level of tissue damage (Gaw *et al.*, 1995). The effect of DMBA inducement and vegetables extract administration on these parameters in the rats is shown in Table 2. The activities of AST,

ALT and ALP were increased following DMBA administration as observed principally in the result of the untreated group. Similarly, the administration of the plants leaf extracts with DMBA inducement on the test groups caused a little reduction in the level of these enzymes as compared to positive control but a significant increment as compared to negative control in the ALT and ALP levels ($p < 0.01$ and $p < 0.05$). The whole concentrations of enzymes measured were seen to differ insignificantly ($p \geq 0.05$) in AST levels within and among the test groups. They were significantly high in comparison to the test and negative control ($p < 0.05$). This research work suggests that the liver might be injured due to DMBA administration. Transaminases performs an important function in protein and amino acid metabolism (Abdelhalim and Moussa, 2013). They are found in the cells of almost all body tissues and when diseases or injuries affected these tissues, they are released into blood stream (Kaplan, 1986). The levels of these enzymes are common markers for hepatic toxicity or tumour ravaging effects; levels of these proteins were rapidly increased when the liver is damaged by any cause, including hepatitis or hepatic cirrhosis (Abdelhalim and Moussa 2013). Some researchers have stated that significant elevation has been noted in the activity of liver enzymes (ALT and AST) after radiation by gamma rays, (Makhlouf and Makhlouf, 2012; El -Deeb, 2006; and Bhatia and Manda, 2004). While other researchers were of the opposite opinion (Abdelhalim and Moussa, 2013).

Histological examination of the liver, colon and breast was carried out to corroborate the phytochemical and biochemical results. A histological change provides strong evidence of toxic damage in the tissues. The present study revealed histological changes in the hepatocytes of Wistar albino rats exposed to DMBA. They were characterized with necrosis, hyperchromasia, multinucleation and congestion in the central portal vein and the sinusoid; control animals showed the central portal vein and hepatocytes were intact. The liver of the groups treated with DMBA along with administration of AH and TT showed slight congestion in the central portal vein and necrosis in the central lobes and hepatocytes. The group treated with BA showed necrosis of the

hepatocytes but with normal central portal vein. This is suggestive that at least, these plant extracts may help in the resolution of hepatic damage or could reverse the damage.

Histology of the colon revealed the mucus gland were normal, the villi and the mucosa folds are intact in control animals while untreated animals showed necrosis of the villi, massive infiltration of inflammatory cells and hyperchromasia of the nuclei indicating the commencement of neoplasia. The treated groups administered with TT and AH showed intact mucus glands, slight necrosis of the villi and mild infiltration of inflammatory cells in the submucosa and muscularis layer. On the other hand, those receiving BA showed slight congestion in the mucus gland, massive cellular infiltration of inflammatory cells in the villi (with mild necrosis), submucosa and muscularis layer.

The mammary tissue of the control group had normal patent acini and ductules with normal musculature. As seen in the untreated group, DMBA administration showed congestion, proliferation of the acini and the ductules and hypertrophy of the connective muscle with distortion of histological architecture. Mammary Tissue of DMBA administered group treated with TT showed hyperplasia in the acini and ductules with some hypertrophy in the connective tissue. Mammary Tissue of DMBA administered group treated with AH showed hyperplasia in the acini, ductules and connective tissues while those receiving BA showed slight proliferation in the acini and hyperplasia in the acini and connective tissue. This revealed that damage done to the mammary gland by DMBA could not be completely treated by the leaf extracts rather it slowed the proliferation rate of neoplasm. This is quite interesting and further investigation needs to be carried out to ascertain these observations.

All these histological observations show that neoplasm had started to develop in the various organs of interest and by implication, the leaf extracts is likely inhibiting the activity and impact of the neoplasm inducing agents. This research is limited by access to funds and other high throughput equipment and molecular techniques. Flow cytometry (study immune populations), immunohistochemistry/

immunofluorescence (identify and visualize markers and molecules) and other ancillary techniques to study pathways or transcription factors affected are sorely needed to better understand this observable features.

Conclusion and Recommendation

With the promising potential of diet and lifestyle changes in the fight against cancer and other diseases, a dietary component with possible anti-neoplastic properties is indeed exciting. Many Africans believe in the power of herbs. However, with the results obtained, these plants could at least help in healing cellular injury or at best suppress the growth of neoplastic cells. Whatever the case, consumption of these vegetables is justified, not as a cure but as a recommendation for a supplement or part of a healthy diet.

Declarations

Ethics approval and consent to participate

This work was approved by the Ethical Committee for the use of Laboratory Animals, Nigeria Defence Academy, Kaduna with reference number NDA/PGS/FS/M/036/15. Written informed consent was obtained for the use of the animals in the institution.

Competing interests

The authors declare that they have no competing interests

Funding

No funding was available for this work

Acknowledgements

We acknowledge the veterinarians of the Department of veterinary anatomy, Ahmadu Bello University, Zaria, Nigeria and Kaduna State University for their support.

List of Abbreviations

ECM - extracellular matrix
 WHO - World Health Organization
 DMBA - 7, 12-Dimethylbenz[a]anthracene
 AH - *Amaranthus hybridus*
 BA - *Basella alba*
 TT - *Talinum triangulare*
 AST - Aspartate aminotransferase
 ALT - Alanine aminotransferase
 ALP - Alkaline Phosphates
 H&E - Haematoxylin and eosin

References

- Abdelhalim, M.A.K and Mouss, S.A.A. (2013). The biochemical changes in rats' blood serum levels exposed to different gamma radiation doses. *African Journal of Pharmacy and Pharmacology*;7(15): 785-792.
- Abubakar, S.D., Adisa, J.O., Sahabi, S.M., Abdullahi, K., Abubakar, U., Fasogbon, S.A. and Zakariya, A.A. (2017). Beneficial Effects of *Guiera Senegalensis* on Selected Parameters in Acetic Acid-Induced Colitis in Wister Rats. *Journal of Complementary and Alternative Medical Research*: 1-3.
- Aja, P.M., Okaka, A.N.C., Onu, P.N., Ibiyam, U and Urako, A.J. (2010). Phytochemical composition of *Talinum triangulare* (water leaf) leaves. *Pakistan Journal of Nutrition*; 9(6): 527-530.
- Akubugwo, I.E., Obasi, N.A., Chinyere, G.C. and Ugbogu, A.E. (2007). Nutritional and chemical value of *Amaranthus hybridus* L. leaves from Afikpo, Nigeria. *African Journal of Biotechnology*; 6(24): 2833-2839.
- Azad, A.K., Wan-Azizi, W.S., Babar, Z.M., Labu, Z.K. and Zabin, S. (2013). An Overview on Phytochemical, Anti-Inflammatory and Anti-Bacterial Activity of *Basella alba* Leaves Extract. *Middle-East Journal of Scientific Research*; 14 (5): 650-655.
- Bako, S.S., Okeke, J.U., Etonihu, A.C., Mohammed, Y., Olanisakin, O.A., Atolaiye, B.O. and Madu, P.C. (2010). Medicinal Values of *Moinga Oleifera* Leave Extracts. Proceedings of the National Summit on *Moringa* Development. (RMRDC Proceedings Series 033). RMRDC Printing Press Utako, Abuja.
- Bhatia, A.L., Manda, K. (2004) Study on pre-treatment of melatonin against radiation - induced oxidative stress in mice. *Environmental Toxicology and Pharmacology*;18(1):13-20.
- Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R.L., Torre, L.A. and Jemal, A. (2018). Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*; 68(6):394-424.
- Bernstein, B.J and Grasso, T. (2001). Prevalence of complementary and alternative medicine use in cancer patients. *Oncology (Williston Park, NY)*. 15(10):1267.



- El –Deeb, A.E., Abd El – Aleem, I.M., Abd El – Rahman, A.A. (2006). The curative effect of some antioxidants on γ - irradiated rats. *Journal of Egypt Society of Toxicology*; 35:79-89.
- Engdal, S. and Nilsen, O.G. (2008). Inhibition of P-glycoprotein in Caco-2 cells: effects of herbal remedies frequently used by cancer patients. *Xenobiotica*;38(6):559-573.
- Frenkel, K., Wei, L and Wei, V. (1995). 7,12-Dimethylbenz[a]anthracene induces oxidative DNA modification in vivo. *Free Radical Biology and Medicine*; 19:373-380.
- Gaw, A., Cowman, R.A., O'Reilly, D.S. and Shepherd, J. (1995). *Clinical Biochemistry: An Illustrated Color Text*. Clinical Biochemistry. New York.
- Global Burden of Disease Cancer Collaboration (2019): Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 29 cancer groups, 1990 to 2017: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*; 5: 1749–1768.
- Kaplan, M.M. (1986). Serum alkaline phosphatase – another piece is added to the puzzle. *Hepatology*;6(3):526-528.
- Khalid, S., Shahzad, A., Basharat, N., Abubakar, M., Anwar, P. (2018) Phytochemical Screening and Analysis of Selected Medicinal Plants in Gujrat. *Journal of Phytochemistry and Biochemistry*; 2: 108.
- Medina, D., Butel, J.S., Socher, S.H., et al. (1980). Mammary Tumorigenesis in 7,12-Dimethylbenzanthracene-Treated C57bl X Db a-2ff1 mice. *Cancer Research*; 40(2):368–373.
- Makhlouf, R., Makhlouf, I. (2012). Evaluation of the effect of Spirulina against Gamma irradiation induced oxidative stress and tissue injury in rats. *International Journal of Applied Science and Engineering Research*; 1(2):152-164
- National Cancer Institute. "Types of Cancer Treatment". About Cancer. <https://www.cancer.gov/about-cancer/treatment/> types. Retrieved on September 2, 2020.
- Okwu, D.E and Omodamiro, O.D. (2005). Effect of Hexane extract and phytochemical content of *Xylopi aethiopica* and *Ocimum gratissimum* on uterus of Guinea pig. *Bio-Research*; 3(2): 40-44.
- Odebiyi, O.O and Sofowora EA. (1979). Phytochemical screening of Nigerian Medicinal plants. 2nd OAU/STRC Inter-African Symposium on traditional Pharmacopoeia and African Medicinal. 216-220.
- Roth, G.A., Abate, D., Abate, K. H., et al. (2017). Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study. *Lancet*; 392:1736–1788.
- Sankhalkar, S., Vernekar, V. (2016) Quantitative and Qualitative analysis of Phenolic and Flavonoid content in Moringa oleifera Lam and *Ocimum tenuiflorum* L. *Pharmacognosy Research*; 8(1):16.
- Sheela, J.A.H. (2013). Qualitative Analysis of Secondary Metabolites of the Plant Clematis Gouriana. *International Journal of Innovative Research in Science, Engineering and Technology*;2(6): 2356-2358.
- Tlsty, T.D. and Coussens, L.M. (2006). Tumor stroma and regulation of cancer development. *Annual Review in Pathology and Mechanical Disease*; 1:119-150.
- World Health Organization. (2020). Global Health Observatory. Geneva: World Health Organization; 2018. who.int/gho/database/en/. Accessed August 21, 2020.
- Zhang, X., Chen, X., Yang, J., Hu, Y., Li, K. (2020a). Effects of nutritional support on the clinical outcomes of well-nourished patients with cancer: a meta-analysis. *European Journal of Clinical Nutrition*;13:1-2.
- Zhang, Y.B., Pan, X.F., Chen, J., Cao, A., Zhang, Y.G., Xia, L., Wang, J., Li, H., Liu, G., Pan, A. (2020b). Combined lifestyle factors, incident cancer, and cancer mortality: a systematic review and meta-analysis of prospective cohort studies. *British Journal of Cancer*; 122(7):1085-1093.

Citation: Famiyesin T.O., Appah, J., Egbe, N., Bello, Z.M., Chukwuebuka, U.I. and Abubakar, S.D. Pathologic Improvements by Some Dietary Plants in an Animal Model of Carcinogenesis. *Sokoto Journal of Medical Laboratory Science*;5(4): 26 - 34.

Copyright. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.