Sahel Journal of Life Sciences FUDMA (SAJOLS)
June 2024 Vol. 2(2):39-47
ISSN: 3027-0456 (Print)
ISSN: 1595-5915(Online)
DOI: *https://doi.org/10.33003/sajols-2024-0202-06*

Research Article

Effects of Tomato and Carrot-Supplemented Diets on Physical and Haematological Characteristics of Wistar Rats Exposed to Breast Carcinogen (Dimethylbenz-[A]-Anthracene)

*** Suleiman Zainab Abubakar, Idoko Ali Siddiq and Aderounmu Ibrahim Ganiyu**

Department of Biochemistry and Molecular Biology, Faculty of Life Sciences, Federal University Dutsin-Ma, Katsina State, Nigeria
****Corresponding Author's email*: zainab.suleiman@umyu.edu.ng; Phone: +2348069768060**

ABSTRACT

Cancer, particularly of the breast, is one of the most common cases of morbidity and mortality in women globally. This research aimed at exploring the potentials of tomato and/or carrot-supplemented diets in mitigating against breast cancer carcinogen, DMBA in rats. Forty-eight female rats were randomly distributed into 8 groups. Groups 1 and 2 comprised of unexposed rats fed standard diet and DMBA-administered group fed standard diet respectively. Groups 3-5 were DMBA-administered groups fed diets containing 20% tomato, 20% carrot, and 20% of an equally mixed tomato and carrot respectively. For groups 6-8, unexposed rats fed diets containing 20% tomato, carrot, and 20% of an equally mixed tomato and carrot respectively. The feeding was for a period of 10 weeks. Feed intake, changes in weight and hematological changes were determined. The exposed rats fed supplemented diets had significantly ($p<0.05$) higher feed intake and percentage weight gain compared with the exposed group fed standard diet. Similarly, the unexposed groups fed supplemented diets had significantly ($p<0.05$) higher feed intake and percentage weight gain in comparison with the unexposed group fed standard diet. DMBA- Exposed group and unexposed group fed 20% tomato-supplemented diet had significantly higher WBC and hemoglobin compared with the control. In conclusion, supplementation of diets with either carrot or tomato improves feed intake in normal rats and antagonizes appetite-suppressing effects of cancer, and ameliorate weight loss in rats exposed to breast carcinogen.

Keywords: Body weight, Breast cancer, Carrot, Dimethylbenz-[a]-anthracene, Tomato

Citation: Suleiman, Z. A., Idoko, A. S. and Ganiyu, A. I. (2024). Effects of Tomato and Carrot-Supplemented Diets on Physical and Haematological Characteristics of Wistar Rats Exposed to Breast Carcinogen (Dimethylbenz-[A]-Anthracene). *Sahel Journal of Life Sciences FUDMA*, 2(2): 39-47. DOI: *https://doi.org/10.33003/sajols-2024-0202-06*

INTRODUCTION

Cancer is not a new disease and has afflicted people all over the world, the word cancer originates from the Greek word Karkinos which was used by a physician Hippocrate (460-370 B.C.) to describe carcinoma tumors (Sudhakar, 2009). Cancer is a disease condition that starts with the distortion of a natural cell resulting in uncontrolled division and growth caused by genetic mutation in the DNA which can occur anywhere in the body (Kooti *et al.,* 2017; Morounke *et al.*, 2017). This mutation can occur or may be induced by other factors like nuclear radiation, electromagnetic radiation, viruses, bacteria and fungi, parasites, heat, chemicals in the air, water and food, free radicals, evolution, and aging of DNA and RNA (Agre *et al.,* 2021). In Africa 1.1 million new cases and 711,429 deaths of cancer were estimated in 2020, having Egypt as the leading country with cancer burden followed by Nigeria the second with an estimated incidence of 124,815(Sharma et al 2022). It is predicted that by the year 2030 there will be more than 13.1 million deaths in the world as a result of cancer. Among all cancers, breast cancer is the most common in women. It is estimated that every year 2.3

million new cases of breast cancer are diagnosed around the globe (Shirode and Jadhav, 2021).

7, 12-dimethylbenz-[a]-anthracene (DMBA) is a prototype of polycyclic aromatic hydrocarbons (PAHs) that upon metabolism produces toxic reactive oxygen species that consequently lead to cancer (Koul *et al*., 2010). This compound is carcinogenic in laboratory animals and there is an increase in human exposure to this compound in food, air, and water which makes it a potential human carcinogen. PAHs are stored in human fat implying that breast tissue would be more exposed to this potential carcinogen (Selamoglu, 2018).

Various methods for treating cancer include the following; Surgery, Chemo Therapy, Hormonal therapy, Radiation therapy, Adjuvant therapy, Immuno therapy (American Society of Cancer, 2020; Milestones in Cancer Treatment, 2020). Chemotherapy involves the use of pharmacologic or natural products that prevent the development of invasive breast cancer either by blocking the DNA damage which initiates carcinogenesis, or by arresting or reversing the progression of premalignant cells in which such damage already occurred (Yi-Sheng *et al.,* 2017). The aforementioned treatments are typically very expensive, toxic and are generally applied when the disease has already spread (Trejo-Solís, *et al*., 2013). It has been well established that eating diets rich in fruits and vegetables is associated with lower-risk of several diseases including cancer due to presence of a wide variety of chemical compounds (Bacanli *et al*., 2017). Fruits, vegetable and whole grains in dietary intake might prevent and even reverse the cellular changes associated with carcinogenesis at the initial stages, thus reducing tumor incidence (Trejo-Solís, *et al*., 2013).

Lycopersicon esculentum belongs to the *Solanaceae* family, popularly called "tomato". It is consumed widely as a vegetable and as processed tomato products. The fruit is rich in anti-oxidative and anti-carcinogenic compounds that include lycopene (Collins *et al*., 2022). Popularly known as carrot, *Daucus carota L* is widely consumed as a root vegetable around the globe. It is rich in fibres, minerals and other antioxidant phytochemicals such as α-carotene (Ismail *et al*., 2023; Fadly *et al*., 2021).

The research therefore investigated the potentials of tomato and carrot-supplemented diets in mitigating cancer-causing effects of DMBA in animal models by evaluating the changes in body weight and hematological parameters.

MATERIALS AND METHODS

Chemicals and Feed Ingredients

All chemicals were of analytical grade and obtained from trusted suppliers. Corn starch was prepared by soaking corn for 48 hours, followed by grinding and sieving (0.02 mm-mesh) and turn into powder by allowing dry at room temperature. Soya bean meal (SBM), pre-mix, salt mix, cellulose, palm oil, methionine, bone meal was procured from Central Market, Katsina.

Experimental Animals

Forty-eight (48) female rats weighing averagely 120 g were purchased from animal house of Biological Science Department, Ahmadu Bello University Zaria. They were kept under controlled light conditions (12-h light/dark cycle at 25^{o}C). Water and diets were given *ad libitum.*

Identification of Samples

Tomatoes and carrots were collected from gardens in Ajiwa, Batagarawa LGA Government of Katsina and taken to Department of Plant Biology Herbarium at Federal University Dutsin-Ma for identification and the following batch numbers were given; *Solanum lycopersicum* (Tomato): V/N FUDMA/PSB/00165 and *Dacus carota* (Carrot): V/N FUDMAB/PSB/00199. The samples were separately washed with clean water, sliced and dried at room temperature under shade. The two samples were separately pulverised to pass through 0.02 mm-mesh sieve and stored in polythene bags at 25^{0}C till required. The sieved tomato and carrot powder were mixed thoroughly in equal ratio to obtain a mixture of the fruit and vegetable.

Feed Formulation

Standard rodent diet was prepared by approximately mixing corn starch, SBM, methionine, mineral mix, vitamin mix, cellulose, palm oil, salt and bone meal as in Table 1 (Idoko*et al*., 2022).

Table 1: Components of the standard rat chow

Feed component	Control diet (g/kg)
Corn starch	554.5
SBM	320
Cellulose	45
Bone Meal	12.5
Palm oil	60
Salt mix	3
Pre-mix	2.5
Methionine	2.5
Total	**1000**

Proximate analysis was carried out for required adjustments.

Diet Supplementations

The supplemented diet was formulated by mixing thoroughly 80 g of standard rat chow with 20 g of each of tomato, carrot powder and a mixture of the two to get 20% of each. Supplementation with 20% have been used by Zaki *et al*. (2014).

Experimental Design

After one week of acclimatization period, the forty-eight (48) female rats weighing about 120 g were divided to have nearly the same average weight into eight groups of six (6) rats per group.

Group 1: Normal control was fed with standard rat chow.

Group 2: Positive control received a single dose of 20 mg/kg b.w of DMBA (orally) in olive oil + standard rat chow

Group 3: The group received a single dose of 20mg/kg b.w of DMBA (orally) in olive oil and maintained on a 20% tomato-supplemented diet.

Group 4: The group received a single dose of 20mg/kg b.w of DMBA (orally) in olive oil and maintained on a 20% carrot-supplemented diet.

Group 5: The group received a single dose of 20mg/kg b.w of DMBA (orally) in olive oil and maintained on a 20% mixed tomato and carrot-supplemented diet.

Group 6: The group received distilled water (orally) in a single dose and maintained on a 20% tomato-supplemented diet.

Group 7: The group received distilled water (orally) in a single dose and maintained on a 20% carrot-supplemented diet.

Group 8: The group received distilled water (orally) in a single dose and maintained on 20% mixed tomato and carrot-supplemented diet.

The rats were maintained on their respective diets and water *ad libitum* for a period of 10 weeks.

Measurement of fed intake and body weight

The daily feed intake and weekly change in weight were recorded to monitor the feeding and growth of the rats.

Sacrifice and sample collection

At the end of the 10 weeks, the rats were weighed, anesthetized with chloroform and sacrificed by cutting the jugular vein. Blood samples were collected into EDTA-treated sample bottles.

Analysis of Hematological Parameters

The hematological parameters were determined from blood samples in EDTA-treated bottles using automated hematology analyzer.

Data Analysis

Data obtained from the experiment were analyzed using the statistical package for social science (SPSS) software for windows version 21 (SPSS Inc., Chicago Illinois, USA) the results were reported as Mean±SEM of the values and Duncan comparison was used to compare the mean values. $P<0.05$ was considered significant.

RESULTS

Changes in Feed intake of Wistar Rats Exposed to DMBA and Fed with Tomato and Carrot Supplemented Diet

Table 2 shows feed intake of Wistar rats administered with DMBA and fed with tomato and carrot supplemented diet. The result indicates significantly ($p<0.05$) increased feed intake in all the groups fed supplemented diets when compared to the control with the exception of the group administered with DMBA and fed with 20% mixed tomato and carrot-supplemented diet. The highest feed intake was seen in the group of normal rats fed 20% carrot-supplemented diet.

Table 2. Feed intake of Wistar rats exposed to DMBA and fed with tomato and carrot supplemented diet

Group	Feed Intake (g)
1	69.16 ± 1.82^{a}
2	77.93 ± 1.73^{b}
3	$84.61\pm3.64^{b\,c}$
4	81.63 ± 2.96^{bc}
5	75.56 ± 2.66^{ab}
6	88.01 ± 3.31^{cd}
7	93.57 ± 2.07^{d}
8	81.64 ± 4.25^{bc}

The result represents the average of three determinants, with the standard error of the mean indicated by Mean±SEM. Values with identical superscripts do not exhibit significant differences ($P<0.05$), while values with different superscript

exhibit significant differences. Group 1: normal rats Fed standard rat chow. Group 2; DMBA administered group Fed standard rat chow. Group 3: DMBA administered group Fed 20% tomato-supplemented diet. Group 4: DMBA administered group Fed 20% carrot-supplemented diet. Group 5: DMBA administered group fed 20% mixed tomato/carrot-supplemented diet. Group 6: normal rats Fed 20% tomato-supplemented diet. Group 7: normal rats Fed 20% carrot-supplemented diet. Group 8: normal rats Fed 20% mixed tomato/carrot-supplemented diet.

Changes in body weight of Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented diet

Table 3 shows the changes in body weight of Wistar rats exposed to DMBA and fed with tomato and carrot supplemented diet. Percentage weight gain was higher in the normal groups fed carrot or tomato-supplemented diet but lower in the group fed mixed tomato and carrot-supplemented diet compared with the normal control. Similarly, the percentage weight gain was higher in the groups administered DMBA and fed carrot or tomato-supplemented diet but lower in the group fed mixed tomato and carrot-supplemented diet compared with the DMBA control.

Profiles of hematopoiesis in Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented-diet

Table 4 shows hematological parameters of Wistar rats exposed to DMBA and fed with tomato and carrot supplemented diet. The result shows significant increase ($p<0.05$) in WBC concentration in cancer group when compared with the normal. However, treatment with carrot and tomato supplemented diet indicated no significant difference in the concentration of WBC among the treated groups. Similarly, the result also indicated no significant difference ($p<0.05$) in the concentrations of RBC, MCV, MCH, LYMPH and GRANU when compared with normal and cancer groups. However, it indicates significant increase in HGB concentration in normal rats fed 20% tomato supplemented diet. Also, there was significant increase in PLT concentration in normal rats fed 20% mixed tomatoes/carrot supplemented diet when compared to the control.

Table 3. Changes in body weight of Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented diet

Group	Initial Body Weight (g)	Final Body Weight (g)	Body Weight diff (g)	% Increase in weight (%)
1	146.3±3.54^{a}	197.9±12.0^{ab}	51.65	35.31
2	138.7±4.32^{a}	184.3±4.62^{ab}	45.63	32.90
3	136.2±7.52^{a}	197.5±5.93^{ab}	61.28	45.00
4	137.9±3.92^{a}	199.8±8.48^{ab}	61.93	44.92
5	137.0±8.33^{a}	180.4±8.60^{a}	43.38	31.66
6	142.7±4.44^{a}	202.1±2.82^{ab}	59.35	41.58
7	146.7±3.93^{a}	206.7±6.61^{b}	60.02	40.91
8	145.1±6.84^{a}	190.7±6.32^{ab}	45.57	31.40

The result represents the average of three determinants, with the standard error of the mean indicated by Mean±SEM. Values with identical superscripts do not exhibit significant differences ($P<0.05$), while values with different superscript exhibit significant differences. Group 1: normal rats Fed standard rat chow. Group 2; DMBA administered group Fed standard rat chow. Group 3: DMBA administered group Fed 20% tomato-supplemented diet. Group 4: DMBA administered group Fed 20% carrot-supplemented diet. Group 5: DMBA administered group fed 20% mixed tomato/carrot-supplemented diet. Group 6: normal rats Fed 20% tomato-supplemented diet. Group 7: normal rats Fed 20% carrot-supplemented diet. Group 8: normal rats Fed 20% mixed tomato/carrot-supplemented diet.

Table 4: Profiles of hematopoiesis in Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented-diet

Group	WBC (10^3/u L)	RBC (10^6/u L)	HGB (g/dl)	MCV (fL)	MCH (pg)	PLT (10^3/u L)	LYMPH (10^3/u L)	GRANU (10^3/u L)
1	3.53±0.31^a	5.50±0.47^a	11.33±0.24^a	87.55±1.11^a	29.43±0.51^a	192.0±40.3^a	6.20±0.15^a	2.70±0.23^a
2	4.13±0.26^{ab}	6.30±0.58^a	13.45±0.60^a	87.48±3.75^a	33.38±2.29^a	178.0±7.33^a	6.18±0.25^a	2.30±0.32^a
3	4.85±0.18^b	6.05±0.96^a	13.03±0.54^a	85.93±2.38^a	29.10±1.14^a	158.8±18.1^a	5.88±0.41^a	2.93±0.33^a
4	4.58±0.50^{ab}	6.10±0.91^a	13.85±0.29^a	88.15±0.62^a	32.08±2.34^a	159.0±6.98^a	6.08±0.28^a	2.50±0.20^a
5	4.78±0.13^b	6.05±0.96^a	12.93±0.50^a	85.83±2.36^a	29.10±1.14^a	183.3±11.2^a	5.53±0.52^a	2.78±0.23^a
6	4.73±0.40^b	5.95±0.16^a	16.10±2.67^b	89.18±0.97^a	30.73±1.03^a	168.8±2.59^a	5.53±0.39^a	2.03±0.24^a
7	5.28±0.34^b	6.25±0.59^a	13.45±0.64^a	87.48±3.75^a	33.38±2.29^a	182.3±8.32^a	5.85±0.39^a	2.55±0.47^a
8	4.60±0.51^{ab}	6.00±0.71^a	12.08±0.27^a	80.05±7.63^a	29.45±0.51^a	242.0±21.4^b	6.05±0.27^a	2.70±0.23^a

The result represents the average of four determinant, with the standard error of the mean indicated by Mean±SEM. Values with identical superscripts do not exhibit significant differences (P>0.05), while values with different super script exhibit significant differences. Key: WBC: White blood cell, RBC: Red blood cell, HGB: Hemoglobin, MCV: Mean capuscular volume, MCH: Mean capuscular hemoglobin, PLT: Platelet, LYMPH: Lymphcytes and GRANU: Granulocytes. Group 1: normal rats Fed standard rat chow. Group 2; DMBA administered group Fed standard rat chow. Group 3: DMBA administered group Fed 20% tomato-supplemented diet. Group 4: DMBA administered group Fed 20% carrot-supplemented diet. Group 5: DMBA administered group fed 20% mixed tomato/carrot-supplemented diet. Group 6: normal rats Fed 20% tomato-supplemented diet. Group 7: normal rats Fed 20% carrot-supplemented diet. Group 8: normal rats Fed 20% mixed tomato/carrot-supplemented diet.

DISCUSSION

Feed intake by Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented diet

DMBA, being a carcinogenic agent, causes poor appetite due to factors that include bowel obstruction, abnormal taste, vomiting and depression (Prajwal and Vijaya, 2024). Other factors include nausea, dysgeusia and dysphagia all of which can modify dietary behavior (Conigliaro *et al*., 2020). The obtained results show that inclusion of tomato or carrot powder increases feed intake both in the groups of normal rats and in the groups administered with carcinogenic agent (DMBA). Feed intake is a function of both physiological state of the body and sensory quality of the food. The significant increase in feed intake in all the treated groups compared to the control groups could be due to improved sensory characteristics such as colour, aroma and texture of the supplemented feeds. According to Chabi *et al.* (2024), addition of tomato in food in different concentrations increases sensory properties of food which they attributed to carotenoid and polyphenolic contents of tomato. Recently, Lu *et al*. (2022) similarly reported that inclusion of tomato in the diet increases feed intake in rats.

Carrot also increases sensory attributes of diet (Ajenu *et al*., 2021) and this could partly be responsible for the increased feed intake in the group fed carrot-supplemented diet. Although, Nicolle *et al*. (2003) postulated long ago that that addition of carrot in the feed of rats may not increase the feed intake, more recent report by Ürüşan and Bölükbaşı (2017) showed that carrots can increase feed intake. Therefore, supplementation with either of carrot or tomato improve feed intake in normal rats, and more importantly obstruct the appetite-suppressing effects of cancer mentioned earlier.

Use of equal combination of carrot and tomato powder as supplement may not act synergistically in improving feed intake both in normal rats and in rats exposed to cancer-causing agent. Rather, the combination appears to be counterproductive as seen in lower feed intakes in groups fed the combination. The reason for this is not yet clear but could be that combination of the two makes diet less palatable.

Changes in Body Weight of Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented diet

The loss of appetite and biochemical alterations as a result of exposure to carcinogens invariable lead to loss of weight particularly from muscle and fat (Patterson, 2017). Furthermore, demand for energy by cancer cells is more than that of normal cells. Therefore, more calories are burnt at rest in cancer cells than in the normal ones. Just as in most benign conditions, weight loss is one of the symptoms of cancer (Nicholson *et al*., 2019; Shephard *et al*., 2016).

From this research, it was seen that tomato or carrot supplements increased weight gain both in the normal rats and in rats exposed to breast carcinogen. This is consistent with the improved calorie intakes in these groups since weight gain is a product of factors that include increased food intake that result in imbalance between calorie intake and energy expenditure (Rashidi *et al*., 2018). It was seen earlier that either tomato or carrot modulates appetite in favor of increased food intake. Supplementation which may involve intake of additional calorie is seen as useful approach for the prevention of weight loss (Prajwal and Vijaya, 2024).

Containing caloric carbohydrate and fat, and containing substantial amounts of vitamins such as C, K, A, E and B-complex vitamins (Elbadrawy and Sello, 2016) which stimulate appetite, the increased weight gain in the groups fed tomato supplement is understandable. Abundant in tomato is lycopene, a compound that has been reported to prevent the spread and development of cancer cells through a series of biochemical reactions (Chen *et al*., 2015). This, it does in synergy with other antioxidants in tomato. By blocking the spread of cancerous cells, tomato ameliorates cancer effects/symptoms that include loss of weight.

Like tomato, carrot is rich in C, A and K vitamins, minerals and antioxidants all of which fortify the immune system. It also contains digestible carbohydrate and fibre which are sources of additional calorie in the diet. The inclusion of carrot may have improved the functionality of the food resulting in improved weight. Carrot contains metabolites that include falcarinol, falcarindiol, polyacetylenes and isocoumarins, all of which have been demonstrated to have anti-breast cancer activities (Kobaek-Larsen et al., 2019; Xu et al., 2019;

Alfurayhi *et al*., 2023). Carotenoids content of carrot have been reported to neutralize free radicals and to inhibit cell proliferations in breast cancer (Larsson et al., 2010; Chen *et al*., 2018). By being anti-carcinogenic, carrot supplement restores poor feeding and weight loss, two important symptoms of cancer. It could also be that increase in the functionality of carrot-supplemented diet is one of the anti-cancer mechanisms of such diets.

The effect of equal combination of tomato and carrot as a supplement in food seems to be having antagonistic effect on weight gain which is consistent with the effect on feed intake. It is possible that combination of the two at the level used provide in the diet excess amount of the micronutrients and phytonutrients. For instance, consumption of vitamins in excess causes nausea and stomach cramp (Verkaik-Kloosterman *et al*., 2012) both of which can suppress appetite and decrease weight gain. Similarly, free radicals have crucial physiological functions such as cell signaling, insulin sensitivity and mitochondrial biogenesis. High levels of antioxidant supplementation could therefore hamper the functions and make the body more vulnerable (Li *et al*., 2022).

From the foregoing, it could be inferred that inclusion of tomato or carrot in the diet at the level used could be very useful in ameliorating appetite and weight-associated breast cancer symptoms in exposed individuals. However, equal combination of the two may not work well in managing appetite and weight crisis in such individuals.

Profiles of hematopoiesis in Wistar rats exposed to breast carcinogen (DMBA) and fed with tomato and carrot supplemented-diet

Estimation of the hematological parameters such as white and red blood cell indices is a powerful tool in the investigation of breast cancer since it causes changes in blood count (Shreya *et al*., 2023). Studies have shown that hematological parameters are decreased in breast cancer due to development of anemia (Divsalar *et al*., 2021; Akuru *et al*., 2019). However, the fall particularly in red blood cell indices occur when the breast cancer is at advanced stage (Shreya *et al*., 2023). This could explain the non-significant differences between the group exposed to breast carcinogen and other groups in RBC, MCV and MCH. The unexposed group of rats fed 20% tomato-supplemented diet had significantly higher HGB compared to the rest; an indication that the diet could be helpful in preventing anemic condition in advanced stage of breast cancer. It could be inferred from the study that 10-week period may not be enough to cause serious distortion and disruption of red blood erythropoiesis in rats exposed to DMBA. The significantly higher WBC seen in unexposed rats fed 20% carrot-supplemented diet is unclear.

CONCLUSION

From the results, it could be concluded that supplementation of diets with either carrot or tomato improves feed intake in normal rats and antagonizes appetite-suppressing effects of cancer, and ameliorate weight loss in rats exposed to breast carcinogen. However, equal combination of the two may not work well in managing appetite and weight crisis in such animal models. It is also concluded from the study that 10-week experimental period may not be enough to cause serious hematological alterations in rats exposed to breast cancer carcinogen.

REFRENCES

Agre, A. M., Upade, A. C., Yadav, M. A., & Kumbhar, S. B. (2021). A Review on Breast Cancer and Its Management. *World J. Pharm. Res*, *10*, 408-437.

Alfurayhi, R., Huang, L. and Brandt, K. (2023). Pathways Affected by Falcarinol-type Polyacetylenes and Implications for their Anti-inflammatory Function and Potential in cancer Chemoprevention. *Foods (Basel, Switzerland),* 12 (6):1192.

American Society of Cancer, (2020). What is cancer? Web link: https://www.cancer.org/cancer/cancer-basics/what-is-cancer.html.

Bacanli, M., Başaran, N., & Başaran, A. A. (2017). Lycopene: Is it beneficial to human health as an antioxidant? *Turkish Journal of Pharmaceutical Sciences*, *14*(3), 311.

Chen, H., Shao, F., Zhang, F., and Miao, Q. (2018). Association between dietary carrot intake and breast cancer: A meta-analysis. *Medicine, 97*(37), e12164.

Chen, P., Zhang, W., Wang, X., et al. (2015). Lycopene and risk of prostate cancer: A systematic review and meta-analysis. *Medicine (Baltimore)*. 94(33): e1260.

Collins, E., Bowyer, C., Tsouza, A., & Chopra, M. (2022). Tomatoes: An Extensive Review of the Associated Health Impacts of Tomatoes and Factors That Can Affect Their Cultivation. Biology 2022, 11, 239.

Conigliaro, T., Boyce, L. M., Lopez, C. A., and Tonorezos, E. S. (2020). Food Intake During Cancer Therapy. *American Journal of Clinical Oncology. 43(11): 813-819.*

Divsalar, B., Heydari, P., Habibollah, G., and Tamaddon, G. (2021). Hematological Parameters Changes in Patients with Breast Cancer. *Clinical laboratory*, (8).

Elbadrawy E., Sello, A. (2016). Evaluation of nutritional value and antioxidant activity of tomato peel extracts. *Arabian Journal of Chemistry,* 9: S1010–S1018.

Fadly, D., Abdul, N. A. R., Muttalib, Y. S. & Bohari, B. (2021). Organoleptic Properties, Proximate Compositions, and Antioxidant Activity of Carrot–Navel Orange Marmalade. *Open Access Macedonian Journal of Medical Sciences*, *9*(A), 488-492.

Ismail, J., Shebaby, W. N., Daher, J., Boulos, J. C., Taleb, R., Daher, C. F., & Mroueh, M. (2023). The Wild Carrot (Daucus carota): A Phytochemical and Pharmacological Review. *Plants*, *13*(1), 93.

Kobaek-Larsen, M., G. Baatrup, M. KhataeiNotabi, R. B. El-Houri, E. Pipó-Ollé, E. (2019). Christensen Arnspang, and L. P. Christensen. 2019. Dietary polyacetylenic oxylipins falcarinol and falcarindiol prevent inflammation and colorectal neoplastic transformation: A mechanistic and dose-response study in a rat model. *Nutrients* 11 (9): 2223.

Kooti, W., Servatyari, K., Behzadifar, M., Asadi-Samani, M., Sadeghi, F., Nouri, B., & Zare Marzouni, H. (2017). Effective medicinal plant in cancer treatment, part 2: review study. *Journal of evidence-based complementary & alternative medicine*, *22*(4), 982-995.

Koul, A., Arora, N. and Tanwar, L. (2010). Lycopene mediated modulation of 7, 12 dimethlybenz (A) anthracene induced hepatic clastogenicity in male Balb/c mice. *Nutricion Hospitalaria*, *25*(2), 304-310.

Larsson, S. C., Bergkvist, L. and Wolk, A. (2010). Dietary carotenoids and risk of hormone receptor-defined breast cancer in a prospective cohort of Swedish women. *European Journal of Cancer,* 46:1079–85.

Li, S., Fasipe, B. and Laher, I. (2022). Potential harms of supplementation with high doses of antioxidants in athletes. *Journal of Exercise Science and Fitness*, *20*(4), 269–275.

Milestones in Cancer Treatment, (2020). Cure Today. Web link: https://www.curetoday.com/search?keywordTerm=Milestones+in+can cer+treatment.

Morounke, S. G., Ayorinde, J. B., Benedict, A. O., Adedayo, F. F., Adewale, F. O., Oluwadamilare, I., ... & Benjamin, A. (2017). Epidemiology and incidence of common cancers in Nigeria. *Population*, *84*(82,231,000), 166-629.

Nicholson, B. D., Aveyard, P., Hamilton, W. and Hobbs, F. D. R. (2019). When should unexpected weight loss warrant further investigation to exclude cancer? *BMJ* 366, l5271.

Patterson, R. C. (2017). Effects of Cancer on the Body. https://healthfully.com/33017-effects-cancer-body.html.

Prajwal, D. and Vijaya R. B. (2024). Diet and Nutritional Supplementation in Patients With Cancer: Is More Necessarily Better? *Journal of Oncology Practice,* 20:3, 311-313

Rashidi, A. A., Heidari, Bakavoli, A. R., Avan, A., Aghasizade, M., Ghazizadeh, H., Tayefi, M., Khayyatzadeh, S. S., Ebrahimi, M., Moohebati, M., Safarian, M., Nematy, M., Sadr-Bazzaz, M., Ferns, G. A. and Mobarhan. G. M. (2018). Dietary Intake and Its Relationship to Different Body Mass Index Categories: A Population-Based Study. *Journal of Research Health Science.* 18(4): e00426.

Sharma, R., Fronterre, C., Ssentongo, A. E., Yenney, K., Amponsah-Manu, F. & Ssentongo, P. (2022). Mapping cancer in Africa: a comprehensive and comparable characterization of 34 cancer types using estimates from GLOBOCAN 2020. *Frontiers in public health*, *10*, 839835.

Shephard, E. A., Neal, R. D., Rose, P. W., Walter, F. M. & Hamilton, W. (2016). Symptoms of adult chronic and acute leukaemia before diagnosis: large primary care case-control studies using electronic records. *British Journal of General Practice,* 66, e182–e188.

Shirode N. G. & Jadhav S. R. (2021). Breast Cancer, Factors Influencing of it and Management of Breast Cancer. *World journal of pharmaceutical research*. 10 (14),507-522. ISSN 2277– 7105

Sudhakar, A. (2009). History of Cancer, Ancient and Modern Treatment Methods. *Journal of cancer science & therapy*, 1(2), 1-4.

Trejo-Solís, C., Pedraza-Chaverrí, J., Torres-Ramos, M., Jiménez-Farfán, D., Cruz Salgado, A., Serrano-García, N. & Sotelo, J. (2013). Multiple molecular and cellular mechanisms of action of lycopene in cancer inhibition. *Evidence-based complementary and alternative medicine*, *2013*.

Ürüşan, H., Bölükbaşı, Ş. C. (2017). Effects of dietary supplementation levels of turmeric powder (curcuma longa) on performance, carcass characteristics and gut microflora in broiler chickens. *Journal of Animal and Plant Sciences,* 27(3): 732-736.

Verkaik-Kloosterman, J., McCann, M. T., Hoekstra, J., and Verhagen, H. (2012). Vitamins and minerals: issues associated with too low and too high population intakes. *Food & nutrition research*, *56*, 10.

Xu, H., Jiang, H., Yang, W., Song, F., Yan, S., Wang, C., Fu, W., Li, H., Lyu, C., Gan, Y., **et al.** (2019). Is carrot consumption associated with a decreased risk of lung cancer? A meta-analysis of observational studies. *The British Journal of Nutrition,* 122 (5):488–98.

Yi-Sheng, S., Zhao, Z., Zhang-Nv, Y., Fang, X., Hang-Jing, L, Zhi-Yong, Z., Wen, S., Jianmin, J., Ping-Ping, Y. and Han-Ping, Z. (2017). Risk Factors and Preventions of Breast Cancer. *International Journal of Biological Sciences.* 13(11): 1387-1397. doi: 10.7150/ijbs.21635.

Zaki, S. A., Amin, W. S., and Nagi, H. M. (2014). The functional role of tomato and carrot on histopathological lesions of brain, small intestine and prostate in mice treated with acrylamide. *Integrative Food, Nutrition and Metabolism*, *1*(1), 114-18.