Comparative Study on Effects of Watermelon and Orange on Glycemic Index, Histopathology and Body Weight Changes in Wistar Albino Rats Following Consumption

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ABSTRACT— ***Glycemic index and histopathological effects of watermelon and orange, as well as their effect on body weight changes were studied on fed Wistar albino rats using varying doses of the juices. 120 g/70 kg body weight was used as the standard dose, and the animals were given the normal dose, × 1.5, and × 2.0 of the normal dose, orally, for a period of six weeks. Our results showed that watermelon caused a significant ($p < 0.05$) dose related increase in blood glucose, while orange caused a significant ($p < 0.05$) dose related decrease in blood glucose after three and six weeks of juice administration. The treatment also showed that orange juice caused a significant ($p < 0.05$) decrease in body weight than watermelon juice. Histopathological findings revealed complications which include necrosis of the liver and degeneration of the glomerular, with the incidence higher for watermelon than orange. These findings, however, make orange a better choice than watermelon for individuals ready to shed weight, and at the same time cautions against long time consumption or over indulgence in the consumption of these fruits, as it may be dangerous for health reasons as in view of the histopathological findings.***

Keywords— Glycemic index, histopathology, normal dose, necrosis, Degeneration of the glumerula (DOG), body weight.

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1. INTRODUCTION

Glycemic Index (GI) is a measure of the effects of carbohydrates on blood glucose levels. It can be interpreted as low GI, medium GI and high GI. Low GI ranges from 55 or less, while high GI ranges from 70 above (Jenkins, 1981). Carbohydrates that breakdown rapidly during digestion releasing glucose rapidly into the blood stream, have a low GI (Jenkins, 1981). Recent scientific evidence have shown that individuals who consumed a low GI diet over many years were at significantly lower risk of developing both type 2 diabetes and coronary heart disease than others. High blood glucose levels or repeated glycemic ‘spikes’ following a meal may promote these diseases by increasing oxidative damage to the vasculature and also by the direct increase in insulin levels (Temelkova-Kurktschiev, 2000). The mixing of high and low GI carbohydrates produces moderate GI values (Jenkins, 1981).

Watermelon is a member of the Cucurbitaceae family. It is a fruit of high GI, and a good source of vitamin C and a very good source of vitamin A, B and notably through its concentration of beta carotene. Watermelon is rich in the B vitamins, necessary for energy production (Collins et. al., 2007). Because of its characteristic higher water and lower calorie content than many other fruits, watermelon supplies more nutrients per calorie (Collins et. al., 2007). The fruit is especially rich in beta-carotene and folic acid, as well as lycopene, the red carotenoid pigment that gives it the red color. This important anti-oxidant is very effective in neutralizing harmful free radicals in the body (Fortin, 1976). The juice from watermelon is highly digestible and completely absorbed of all its mineral contents, providing much needed nutrients to the body. Watermelon helps in preventing cholesterol from clogging arteries and can increase high density lipoproteins (HDL) (good cholesterol), reducing the risk of cardiovascular diseases. The combination of folic acid and the other essential vitamins in this fruit plays an important role in reducing the risks of heart attacks, stroke and colon cancer.

Orange fruit (Citrus sinensis) contains flavonoids and vitamin C. It is also rich in vitamins (A, B and C), mineral salts, pectin and beta-carotene (Collins et. al. 2007). Oranges have about 170 phytonutrients and over 60 flavonoids with anti-tumor, anti-inflammatory, blood clot inhibiting and antioxidant properties (Ensminger, 1986). For instance, vitamin C in oranges helps in preventing the hardening of arteries and thus prevents arteriosclerosis. The orange peels contain the alkaloid synephrine, which can control the production of cholesterol in the liver. The antioxidant elements in oranges combat oxidative stress that oxidizes the low density lipoproteins (LDL) in the blood. Vitamins, flavonoids and other materials in oranges reduce the risk of cardiac problems.

Watermelon and orange are common fruits in Nigeria generally consumed without precautionary measures. In this study, we investigated the blood glucose levels (glycemic index), histopathological and body weight changes in Wistar albino rats, for health benefits, as influenced by watermelon and orange.

2. MATERIALS AND METHODS

Experimental animals: Thirty-five albino rats of the Wistar strain weighing between 70-156 g were obtained from the National Institute of Medical Research, Lagos, Nigeria. The rats were kept in clean disinfected cages with raised wire floor in the animal house (of the department of biochemistry, Igbinedion University, Okada), with 12 hr light/dark cycle and 50-60 % relative humidity at a temperature of about 30^{o}C and allowed to acclimatize to the new environment for two weeks, with free access to water and feed (Guinea growers mash). The rats were treated according to the Nigerian guidelines for the care and use of laboratory animals. The rats were then weighed (baseline) and randomized into seven groups (namely A, B, C, D, E, F and G) of five animals each. Group A rats served as control while groups B to G rats served as tests. At weeks three and six after juice administration, the weights of the experimental rats were also determined.

Plant materials (fruits): Fresh ripened Watermelon and Orange fruits were obtained from local dealers in Benin City, Edo State (Nigeria) and were identified and authenticated by a taxonomist in the Department of Plant Science, University of Benin, Nigeria.

Preparation of juice: Watermelon; the red pulp was homogenized in a blender and filtered with the use of a filter pan (the filter pan is equivalent to four folds of bandage or sheet of cheese cloth), and weighed. Orange; the juice was squeezed out and filtered to remove the seeds and fibers, after which it was weighed.

Administration of juice: Using 120 g/70 kg body weight as standard (normal) dose (Mendosa, 2003), groups B and E were given normal dose of watermelon and orange juice respectively, groups C and F were given ×1.5 of the normal dose of watermelon and orange juice respectively, and groups D and G were given ×2.0 of the normal dose of watermelon and orange juice respectively. The juices were administered, orally, once a day, for a period of six weeks. The control group received equivalent amount of water, via the same route. The body weights of the animals were determined, prior to administration of juice (after acclimatization), at three weeks of juice administration and at six weeks of juice administration.

Sample collection and Preparation: At weeks three and six, blood samples were collected from the rats, after 12 hours fast, via their tails. Also, at week six, after administration, the rats were sacrificed by making incisions at their abdominal regions with dissecting set with the help of chloroform. Blood samples were also collected, while the kidneys and livers were taken and put in a universal bottle containing formal saline. The blood samples were kept in fluoride oxalate bottles, centrifuged at 3500 rpm for ten (10) minutes and the plasma separated. The plasma was used for glucose determination by the spectrophotometry method. The kidneys and livers were taken immediately for histopathological analysis.

Statistical Analysis: Data are represented as Mean ± S.E.M (n = 5). Significance of Difference was tested by Student T-Test, ANOVA and Turkey-Kramer test, using the GraphPad Instat Version 3 (GraphPad Software Inc. San Diego, California U.S.A.). Statistical Significance was set at $P < 0.05$.

3. RESULTS

Table 1: Effects of watermelon and orange juice on blood glucose concentrations (mg/dl) of normal rats.

WEEKS	CONTROL	WATERMELON			ORANGE		
	A	B (normal dose)	C (×1.5 normal dose)	D (× 2.0 normal dose)	E (normal dose)	F (× 1.5 normal dose)	G (× 2.0 normal dose)
THREE	89.3 ± 4.8	95.7 ± 7.6	108.5 ± 5.8**	119.8 ± 6.5**	85.5 ± 7.5	82.8 ± 3.5*	80.6 ± 4.5*+
SIX	101.6 ± 10.5	118.4 ± 10.2**	127.8 ± 8.7**	135.3 ± 8.5**	82.6 ± 4.8*	79.8 ± 6.2*	76.7 ± 8.3*+

Values represent MEAN ± S.E.M. of glucose concentration (mg/dl). n = 5, *p < 0.05, **p < 0.05, compared to control, +p < 0.05, compared to D. Normal dose = 120 g/ 70 kg body weight.

Table 2: Effects of watermelon and orange juice on body weight (g) of normal rats.

WEEKS	CONTROL	WATERMELON			ORANGE		
	A	B	C	D	E	F	G
ONE (Baseline)	121.2 ± 6.2	116.4 ± 7.5	119.4 ± 3.1	130.4 ± 10.1**	104.0 ± 9.0	93.4 ± 6.4	117.0 ± 10.0*+
THREE	163.8 ± 1.9	155.1 ± 6.9	151.7 ± 5.2	159.7 ± 8.5**	157.3 ± 16.0	127.2 ± 5.5	155.3 ± 12.5*+
SIX	188.6 ± 3.5	177.4 ± 9.6	177.8 ± 4.6	176.0 ± 6.5**	172.9 ± 16.3	174.1 ± 9.2	159.7 ± 12.3*+

Values represent MEANS ± S.E.M. of body weight. n = 5, *p < 0.05, **p < 0.05, compared to control, +p < 0.05, compared to D.

Table 3: Histopathological effects of watermelon and orange juice in normal rats

SN / GROUPS	KIDNEY					LIVER				
	1	2	3	4	5	1	2	3	4	5
A	Norm	Norm	Norm	DOG	Norm	Norm	Norm	Nec.	Norm	Norm
B	DOG	DOG	DOG	DOG	DOG	Nec.	FCL	Nec.	Nec.	Nec.
C	DOG	DOG	DOG	DOG	DOG	Nec.	Nec.	Norm	Nec.	Nec.
D	DOG	DOG	DOG	DOG	Norm	Nec.	Nec.	Nec.	Nec.	Norm
E	Norm	DOG	DOG	DOG	Norm	Norm	Nec.	Nec.	Norm	Nec.
F	DOG	Norm	Norm	ST and DOG	DOG	Norm	Nec.	Nec.	Nec.	Norm
G	Norm	DOG	DOG	DOG	Norm	Nec.	Norm	Nec.	Nec.	Nec.

Key: DOG = Degeneration of the Glomerula

FCL = Fatty Chains of the Liver

Norm = Normal

Nec. = Necrosis

ST = Swollen Tubules

Table 1 shows the effects of watermelon and orange juice at different concentrations on the blood glucose concentrations (glycemic index) of rats. After three and six weeks of administration, watermelon juice (normal dose) caused a significant (**$p < 0.05$) increase in the blood glucose compared to the control. Increasing (higher) dose caused significant (**$p < 0.05$) increases in values of glucose. Orange juice, on the other hand, caused a significant (*$p < 0.05$) decrease in blood glucose after three and six weeks of administration, compared to the control. Increasing (higher) dose of orange juice caused significant (*$p < 0.05$) decreases in values of glucose. The results, after three and six weeks of juice administration, also showed that glucose concentrations was significantly ($^{+}p < 0.05$) lower in groups of rats treated with orange juice compared to that treated with juice from watermelon. Table 2 shows the effects of watermelon and orange juice on the body weight of the animals. The body weights were shown to decrease significantly (**$p < 0.05$) with decrease in dose, after three and six weeks of administration of watermelon juice. Group D rats (given ×2.0 of the normal dose of watermelon) is however an exception, which rather showed a significant (**$p < 0.05$) reduction compared to control. Orange juice also caused a significant (*$p < 0.05$) reduction in glucose, when compared with the control. This reduction is however, also dose related. Orange juice caused a significant ($^{+}p < 0.05$) reduction in glucose (group G) when compared with watermelon (group D). Histopathological analysis (Table 3) revealed degeneration of the glomerular of the kidneys in groups B, C, and D, treated to watermelon juice. The watermelon juice also caused fatty chains of the liver in one of the animals in group B, with necrosis of the liver in most animals of the other groups (i.e. group C and D). Orange juice also caused degeneration of the glomerular of the kidneys in groups E, F, and G, with lower incidence when compared to that of watermelon. The juice (orange) also caused necrosis of the liver, with lower incidence, compared to that of watermelon.

4. DISCUSSION

Watermelon and orange are common fruits which individuals consume, most especially people on a strict dietary regime. Watermelon juice which is easily digestible and completely absorbed tends to release much glucose into the system at a time, causing glycemic ‘spikes’. It falls among carbohydrates that break down rapidly during digestion and these carbohydrates have the highest glycemic index (Jenkins et. al. 1981), with its glycemic index between72-80 (Mendosa, 2003). Orange is a fruit of low glycemic index that breaks down slowly, releasing glucose gradually into the blood stream and this for most people is of significant health benefit. The slowing down of the rate of digestion and absorption of foods like carbohydrate indicate greater extraction from the liver and the peripheral blood, of the product of carbohydrate digestion (Jenkins et. al. 1981). Our findings showed that watermelon caused a significant ($p < 0.05$) dose related increase in blood glucose while orange caused a significant ($p < 0.05$) dose related decrease in blood glucose after three and six weeks of juice administration. The dose related increase in blood glucose caused by watermelon result from rapid breakdown of its carbohydrate, resulting in high glycemic index. This tends to cause less extraction from the liver and peripheral blood of the product of carbohydrate digestion, which means more storage of these products and consequent synthesis of fat. While the dose related decrease in blood glucose caused by orange result from slow breakdown of its carbohydrates resulting in low glycemic index. This tends to cause increase extraction from the liver and peripheral blood of the product of carbohydrate digestion, which means less storage of these product and less synthesis of fat. The increase in storage products and synthesis of fat by consumption of watermelon juice, as compared to the likely decrease in storage products and synthesis of fat by consumption of orange juice, lay credence to our findings on their effects on the body weights of the experimental animals. Our study revealed that, comparatively, orange juice caused a significant ($p < 0.05$) decrease in body weight than watermelon juice. This body weight changes may not be unconnected with the effects of these juices on the blood glucose level and its metabolism. The glucose level in the animal blood is dependent on the amount originating from dietary sources and those generated by the animal’s metabolic processes, such as glycogenolysis and gluconeogenesis. Feeding on food with high glycemic index continually by an adult for a long period of time can naturally culminate into a hyperglycemic condition which can degenerate to obesity, diabetes e.t.c. These however make orange a better choice than watermelon for those individuals who are ready to lose weight. In fact, this is likely a rational for the long time practice of the consumption of orange, without caution, by individuals trying to lose weight. However, the long-time consumption of these fruits may not be too safe for health benefits as the histopathological study on the liver and kidneys of the experimental animals’ revealed complications, when the test animals are compared with the control. These complications which include necrosis of the liver and degeneration of the glomerular might have been caused by the vitamin C content of both fruits, which is in high concentration. High doses of vitamin C have been implicated to cause such defects on long time exposure in various past research studies (Jacob et. al., 1999). The higher incidence of these complications caused by watetrmelon than that caused by orange may also point to the fact that watermelon contains more vitamin C than orange.

5. CONCLUSION

This study is however suggestive that the negative effect of these fruits, as implicated by the histopathological results, can be avoided by discouraging an over indulgence in the consumption of these fruits.

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