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SINGLE AND MULTIPLE DOSE EFFECTS OF ETHANOL CONSUMPTION ON THE RATE OF GASTRIC EMPTYING AND ABSORPTION OF FOOD MATERIALS IN THE SMALL INTESTINE OF WISTAR RATS

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ABSTRACT

The rate at which the stomach empties is regulated by signals from both the stomach and duodenum. Usually, chyme empties into the duodenum at a rate not greater than the rate at which it can be digested and absorbed into the small intestine. The present study was undertaken to determine the effects of multiple and single dose of ethanol on the rate of gastric emptying and absorption of food materials in the small intestine. Eighteen male rats with an average weight (220±0.67) were divided into 3groups (n=6). They were each feed with the 11g of the prepared test meal. The control rats were allowed free access to water, while the experimental rats were given 2.73g/kg ethanol orally. Once for the single dose group, and daily for 2weeks for the multiple dose group. At the end of three hours, blood samples were collected for analysis and the abdomen of the rats were cut open after being anaesthetized, to determine the quantity of food left in the stomach in each group. The result showed a statistically significant difference in mean blood levels of plasma triglycerides, proteins and glucose. Triglycerides (control –117.08±9.27mg/dl, single dose – 151.67±6.79mg multiple dose – 185.35±2.11mg/dl). (glycerol phosphate oxidase method-Tietz, 1995) Glucose (Control – 87.49±1.67mg/dl, Single dose—76.92±2.22mg/dl, Multiple dose-68.82±1.41mg/dl). (Glucose oxidase method- Teuscher and Richterich, 1971). Proteins (Control –7.08±0.19g/dl, Single dose – 6.01±0.05g/dl, multiple doses – 5.35±0.09g/dl). (Biuret method-Tietz, 1995). Rate of gastric Emptying, gotten by dividing the gastric emptying by 180minutes showed, (0.025±002g/dl – control, 0.021±0.01g/min – single dose, 0.019±0.01g/min –multiple doses). Ethanol consumed either as a single dose or multiple doses can alter the rate of gastric emptying and absorption of food material in the small intestine.

Keywords: Ethanol, Absorption, Small intestine, Chyme.

INTRODUCTION

Stomach emptying is promoted by intense peristaltic contraction in the stomach antrum. At the same time, emptying is opposed by varying degree of resistance to passage of chyme at the pylorus. The rate at which the stomach empties is regulated by signals from both the stomach and the duodenum. However, the duodenum provides by far the more potent of the signals, controlling the rate at which chyme empties into the duodenum [1]. Digestion and absorption in the small intestine is dependent on a normal supply of pancreatic digestive enzyme, bile and an adequate absorptive surface area. The rate of diffusion of any substance across a membrane has been reported to be proportional to its lipid solubility. Alcohol being a

highly lipid soluble substance, has been reported to interfere with the normal functioning of the gastrointestinal tract. It interferes with smooth muscle contractility[1,2,4], intestinal permeability, as well as enzyme activities and release causing delayed absorption of food materials[5,6]. There could also be reflux esophagitis, gastritis, and pancreatitis with gastric and intestinal mucosal erosion[7,8]. Conflicting reports are found in literatures concerning the effects of alcohol on the rate of gastric emptying. Addolarato G., Montalto M., Capristo E., et al., (1997), reported gastric emptying both in humans and experimental animals to be accelerated[9] , while Wilson C.A, Bushnell D., and Keshavarzian. (1990), reported delayed gastric emptying with alcohol ingestion[10]. This study attempts to contribute to the accumulating information by assessing the effect of alcohol on the absorption of food materials via assaying the plasma levels of glucose, protein and triglyceride, as well as histological studies of both the gastric and small intestinal mucosa.

MATERIALS AND METHODS

Eighteen (18) male wistar rats weighing between 200 to 250g were procured from the breeding colony of the college of Health Sciences, Delta State University, Abraka.
They were housed in plastic cages in the Animal House of the Faculty of Basic Medical Sciences, Delta State University, Abraka. They were acclimatized for 2weeks before the experiment commenced, through out the experiment, they were allowed free access to clean drinking water and standard rat food.

ANIMAL EXPERIMENT

The eighteen rats were divided into 3groups of 6 rats each (i.e. n=6). They were each feed a meal containing 10g of rat chow mixed with 1g of activated charcoal (marker). The first group (control) was given water ad libitum, while groups 2 and 3 received (2.73g/kg body weight) alcohol as a single and (2.73g/kg body weight) alcohol daily for 2weeks, respectively. The animals were treated for 2weeks. Each group of rats was studied for 48hours. The rats were starved for the first 24hours, after which, each was allowed to fed on the test meal (10g chow+ 1g charcoal) for an hour. After the feeding, ethanol was administered to the alcohol groups with the aid of an Oro-gastric tube, while the Control group received water. Three hours after the feeding, the rats were anaesthetized using chloroform and blood was collected for analysis of plasma glucose, triacylglycerol and protein levels. The abdominal cavity was then cut open and the stomach and small intestine disserted out. The stomach was cut open and the food materials in each rat's stomach was carefully collected and dried for 48hours under atmospheric temperature. The Sun dried food was then weighed using an electronic weighing machine until a constant weight in each case was established. The food not eaten by each rat was also weighed, and the actual amount, consumed by each rat was calculated by subtracting the amount left from the total quantity give. The quantity of food that transited from the stomach to the small intestine within the three hours was also obtained by subtracting the quantity of food in the stomach from the quantity consumed by each rat, these amount represent the rate of gastric emptying. Sections of the stomach and the duodenum of rats in each group were processed for examination.

STATISTICAL ANALYSIS

The results were expressed as mean ± SD. The means of the experimental and control groups were compared using computerized software – Microsoft Excel 2003 by the student's t-Test assuming unequal variance and single factor ANOVA test. P values less than 0.05 were considered to be statistically significant.

RESULT

Eighteen male Wistar rats with a mean average weight of (220± 0.67), divided into three groups of six each was used in this study. And an alcohol concentration of (2.73g/kg body weight) was administered. The results are as presented.

Table 1: Effect of single and multiple doses of alcohol treatment on gastric emptying in Wistar rats.

	Control	Single Dose ethanol	Multiple Dose ethanol
Food in Stomach(g)	2.43 ± 0.13	3.20 ± 0.15	3.58 ± 0.14
Quantity of Food Ingested(g)	6.91 ± 0.25	6.95 ± 0.20	7.03 ± 0.12
Amount of Food Transited into Intestine(g)	4.49 ± 0.19	3.62 ± 0.11	3.05 ± 0.04
Rate Gastric Emptying(g/min)	*0.025 ± 0.02	*0.021 ± 0.01	*0.019 ± 0.01

Values are expressed at Mean ± SD for n=6 rats per group.
*Significantly different from control (P<0.05).

The food in the stomach was greater in the multiple dose alcohol treated rats than in the single dose alcohol treated rats and both were greater compared with the control. The quantity of food transited from the stomach into the small intestine was correspondingly greater in the control than in the alcohol treated (both single and multiple) rats and the rate of gastric emptying was similarly higher in the control group. (These difference were significant, (P<0.05).

Table 2: Effect of single and multiple doses of alcohol treatment on nutrients absorption in Wistar rats.

	Control	Single Dose ethanol	Multiple Dose ethanol
Fat Absorption (Plasma TG level [mg/dl])	117.08 ± 9.27	151.67 ± 6.79	185.35±2.11
Glucose Absorption (Plasma Glucose level [g/dl])	87.49 ± 1.67	76.92 ± 2.22	68.82±1.41
Protein Absorption (Plasma Albumin level [g/dl])	4.49 ± 0.15	3.62 ± 0.11	3.05±0.04
Protein Absorption (Plasma Total Proteins [g/dl])	7.08 ± 0.19	6.01 ± 0.65	5.35±0.09

Values are expressed at Mean ± SD for n=6 rats per group.

*Significantly different from control (P<0.05).

The results showed that alcohol treatment increased the absorption of fat both in single and multiple dose alcohol treated rats as shown by the elevated plasma triglycerides level. There was however, a decrease in the absorption of carbohydrate and protein in both the single and multiple dose alcohol treated rats as shown by the plasma glucose and protein levels. The reduction was however, observed to be more in the multiple dose alcohol treated rats than in the single dose alcohol treated rats. And they were both significantly different from the control. (P<0.05)

Histological slides

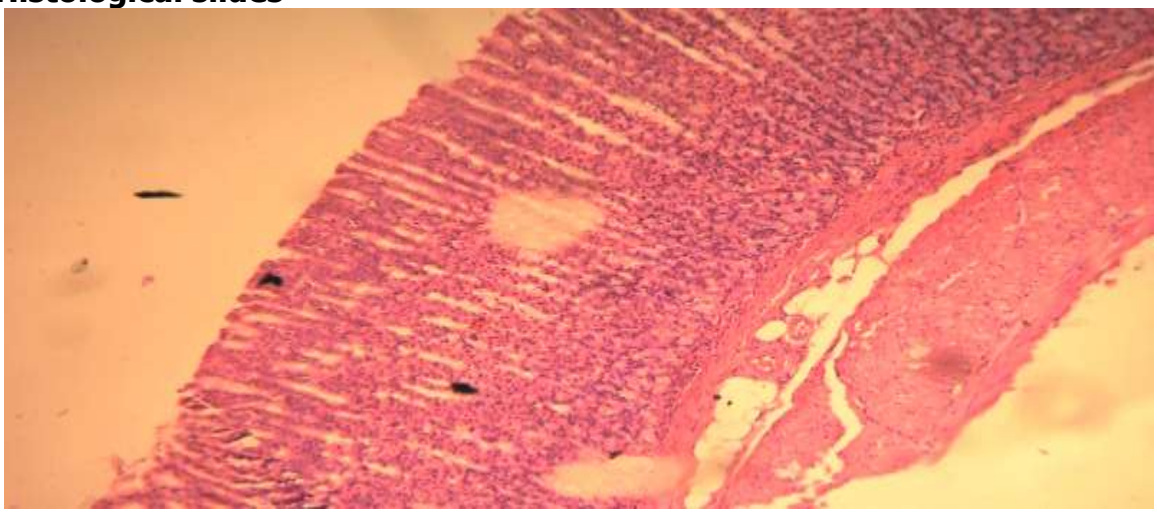

Fig 1: Normal section of the stomach (Control) x100

A section of the stomach showing an intact mucosa composed f mucosal cells lining the fovea and parietal cells interspersed by chief cells lining the gastric glands. The Submucosal and muscular propria layers are intact.

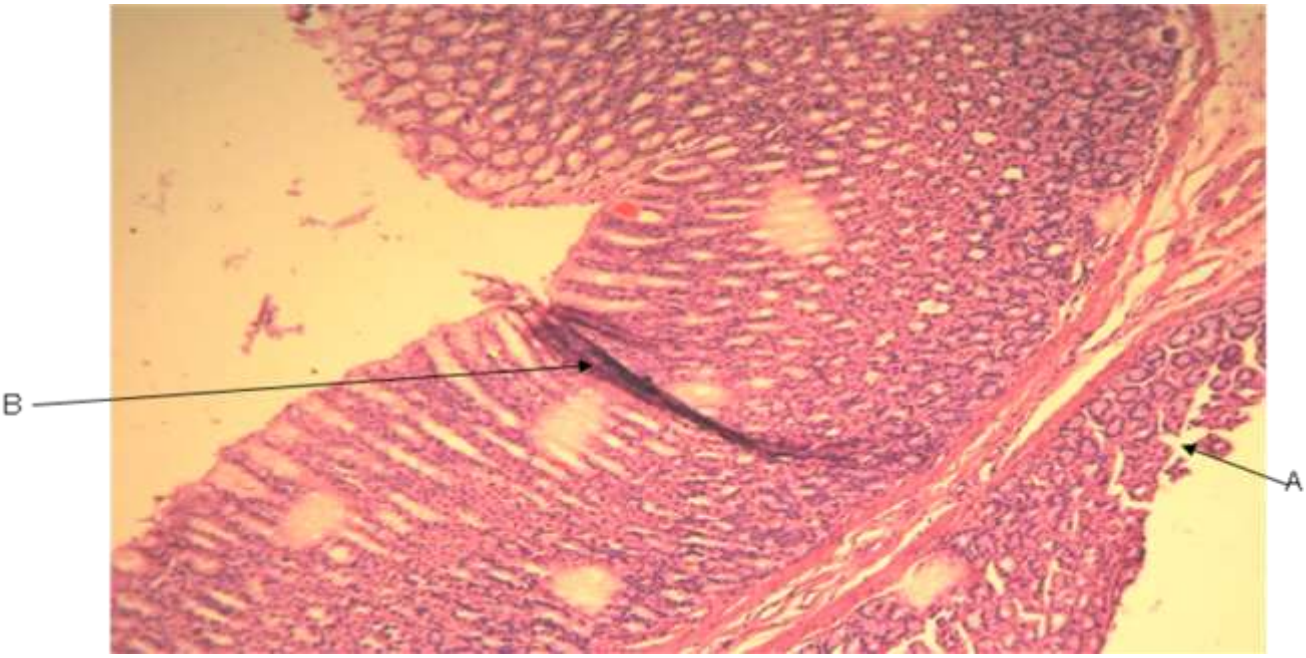

Fig 2: Section of the stomach (Multiple doses) x100
A section of the stomach showing marked erosion of the lining epithelium with marked reduction in gland density (A). Foci of necrosis are seen within the mucosa (B).

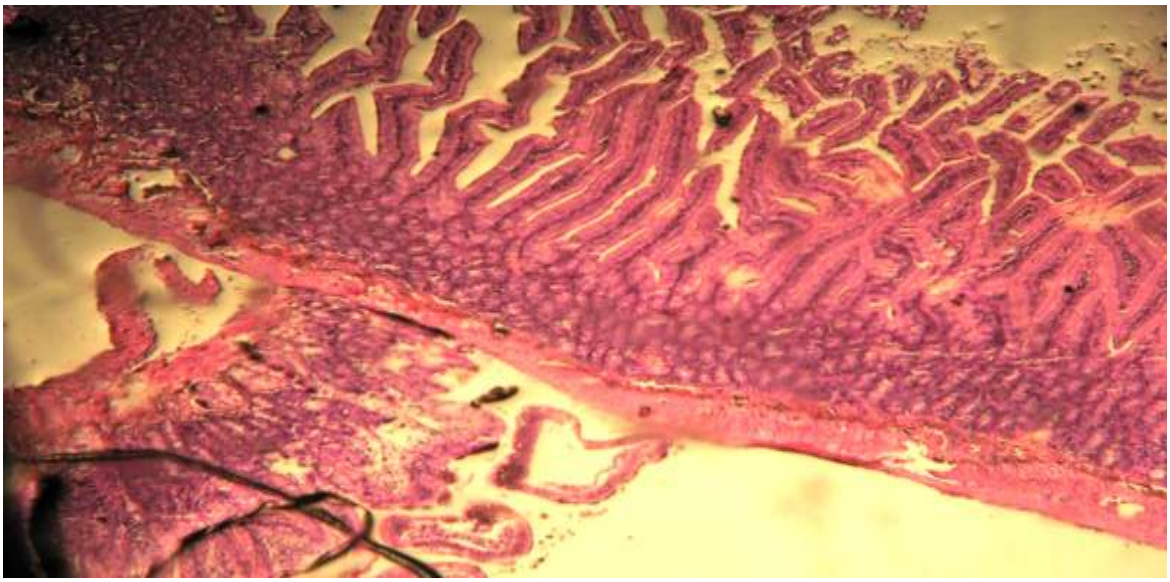

Fig 3: Section of the duodenum (Control) x100
It shows an intact mucosa lined predominantly by mucous cells and interspersed by few goblet cells. Brunner type glands are seen in the sub mucosa. The muscularis propria layer is intact.

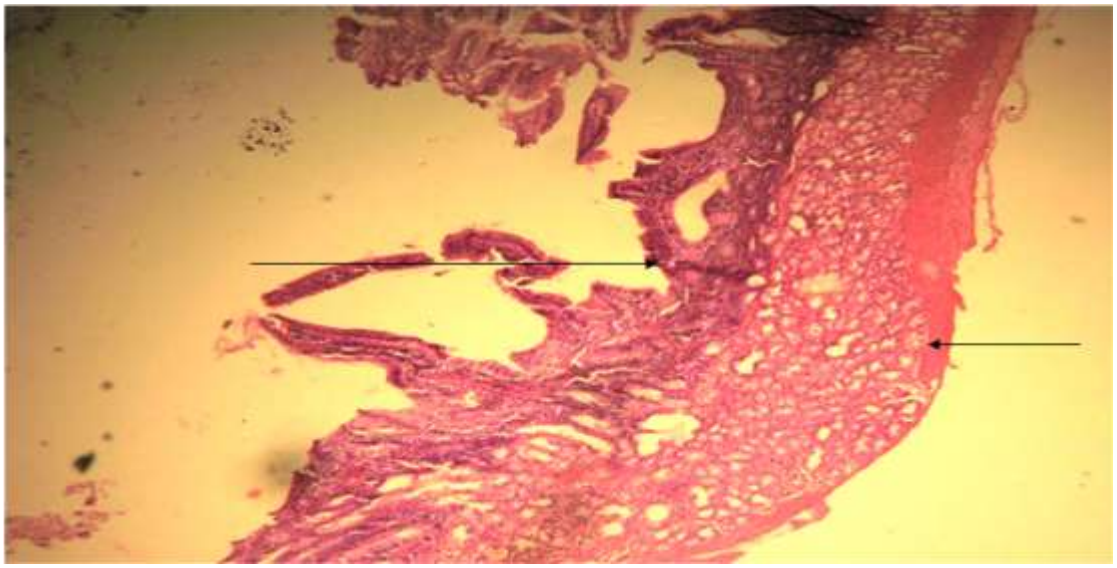

Fig 4: Section of the duodenum (multiple doses)
It shows marked atrophy of the muscular wall (B). The villi are in disarray and they are lined by dysplastic epithelia cells (A). The Brunner's glands appear atrophied

DISCUSSION

Alcohol has been reported to produce a variety of structural and functional alterations in the gastro intestinal tract, depending on the concentration and duration of exposure [7,8,11,12,13,14,15]. Single and multiple doses of 2.73g/kg body weight ethanol administered in this study was observed to cause a decrease in the rate of gastric emptying as well as increase absorption of fat, while decreasing the absorptions of protein and carbohydrate within the small intestine. The decrease in the rate of gastric emptying observed was more with multiple doses administration. This observation was similar to that of[16] Ferenc I, Tibor W, Sandor C, et al, (2001), who worked with rats and reported an inhibition of gastric emptying and small bowel transit with a single large dose of alcohol (2.5g/kg body weight).
Delayed gastric emptying and bowel transit following an intake of 6 units of alcohol was also reported in other study as well [17]. The experiment on nutrient absorption within the small intestine revealed the following; a decrease in the absorption of carbohydrate and protein as expressed in the reduction of plasma levels of glucose, albumin and total protein with alcohol ingestion. A similar observation was reported by Cook EB, Preece JA, Tobin SD et al, (1988) [18]. In the case of fat absorption, single and multiple dose of ethanol ingestion was observed to cause an increase in absorption as expressed in the elevated levels of plasma triglycerides.
Histological examination using Hematoxylin and Eosin (H&E) staining technique showed the following; in the rat's stomach, there were mucosa erosion, with atrophy of the mucosa lining. There were also reductions in gland density with foci´s of necrosis, further supporting a similar observation reported by Bode, C.; Maute, G.; and Bode, J.C, (1996) [15]. In the small intestine, there were gland atrophy, atrophy of the muscular is propria, stroma fibrosis with inflammatory cell infiltrates and the villi were in disarray.

The results observed in the experimental groups were statistically, significantly different ($p<0.05$) from the control group, hence ethanol at 2.73g/kg body weight administration both as a single or multiple dose alters both the rate of gastric emptying and absorption in the small intestine. The microscopic changes observed in the stomach and small intestine following ethanol administration could be said to be responsible in part for the delayed gastric emptying and altered nutrient absorption. With this knowledge, it is recommended that further studies be carried out in this area to ascertain if all the changes observed with ethanol ingestion are reversible with complete withdrawal of ethanol after a period of a usage.

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