

# EFFECTS OF SUB-ACUTE ADMINISTRATION OF FERMENTED *ELAEIS GUINEENSIS* SAP (PALM WINE) ON THE BRAIN VOLUMES AND TOTAL BODY WEIGHTS OF ADULT WISTAR RATS

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**Abstract:** Background: The sap from oil palm (*Elaeis guineensis*) notably called “palm wine” is a popular traditional alcoholic beverage commonly consumed in very large and chronic dimensions by the multitude for either cultural, personal or ceremonial reasons. It is known to have alcoholic contents upon fermentation. Aim: This study aimed at investigating the effect of sub-acute administration of fermented *Elaeis guineensis* sap (palm wine) on morphometric parameters such as total body weight and brain volume using adult wistar rats. Methodology: Unadulterated palm wine was authenticated as genuine *Elaeis guineensis* Sap, diluted with 50% clean tap water, and allowed to ferment at room temperature for 24 hours before being administered to the rats. Twenty five (25) healthy male wistar rats with average weight of 200g were divided into five groups (n=5). Group A served as the normal controls and received only rat chow and distilled water daily. Group B, C, D, and E were received increasing volumes of fermented palm wine via oral cannulas in progressions of 1ml, 2ml, 4ml, and 8ml respectively. The experimental procedure for this study lasted for 14 days. Total body weights of the experimental animals were noted on intervals (Day 1, 5, 10 and 15). 24 hours after their last administration (Day 15), the rats were sacrificed under ketamine (100mg/ml) as anesthesia. Their brain mass were carefully harvested whole and weighed via water displacement method to determine the total brain volume. Results: Higher doses relatively led to drastic reduction in total body weights and increased brain weights/volume of the experimental animals used relative to the control at the end of the experiment. Conclusion: The fermented sap from oil palm (*Elaeis guineensis*) clearly demonstrated a dose dependant undesirable effect on the morphometric parameters investigated.

**Keywords:** *Elaeis guineensis*, Alcoholic beverage, Morphometric parameters.

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## 1. INTRODUCTION

Palm wine is a popular traditional alcoholic beverage consumed by more than 10million people in West Africa (FAO, 1998). It has a milky in appearance and is derived from the sap of various species of palm tree, notably oil palm (*Elaeis guineensis*) and its relatives (Rundel *et al.*, 2002). It plays an important cultural role, and is commonly consumed in many social ceremonies among Nigerians including the Igbos of the South -Eastern region (Eluwa *et al.*, 2010).

The drink is a rich nutrient medium containing sugar, protein, amino acid, alcohol, vitamins and minerals (Ezeagu and Fatunso, 2003). It also contains a dense population of yeasts (Bassir and Maduagwu, 1978). Thus, if allowed to stand, fermentation converts the sugar to alcohol, and subsequently to acetic acid leading to loss of sweetness, shortened shelf-life and decreased acceptability (Odunfa, 1998). Osim *et al.*, (1991) reported that oil palm (*Elaeis guineensis*) sap may contain up to 5% ethanol. Bassir, (1962) also reported that fresh palm sap usually contains no alcohol but levels could rise to 4.5-5.2gm/100 ml after 72 hours. Fermentation practically ends when the pH falls to 4.0; the whole process lasts about 48 hours (Bassir, 1962).

Total brain volume is an integrated measure of health and may be an independent indicator of mortality risk independent of any one clinical or subclinical disease state (Saskia *et al.*, 2016). A physiological change in brain volume is used to access the degree of brain damage being brought about by certain circumstances. A loss in brain volume is a marker of neurodegeneration and predictor of disability progression (Narayanan, *et al.*, 2020). Total brain volume is measured via magnetic resonance imaging (Saskia *et al.*, 2016; Narayanan, *et al.*, 2020).

The brain is a major regulator of physiologic course of actions including motor and cognitive functions (Saskia *et al.*, 2016). A loss of brain tissue is called atrophy. It is used as a marker of cerebrovascular disease and neurodegeneration in the assessment of stroke and dementia in people of older ages (Saskia *et al.*, 2016). Brain atrophy may be a sign of a range of subclinical disease states and problems from inadequate metabolic regulation, much of which has not been satisfactorily characterized (Saskia *et al.*, 2016).

Several psychosocial, physiological, metabolic and pathologic problems have been associated with alcohol consumption (Tien *et al.*, 1990). Palm wine is one of the favorite alcoholic drinks of the Igbos, which is consumed in very large and chronic dimensions without many details on its effect on the brain.

## 2. MATERIALS AND METHODS

### Palm Wine Collection, Authentication and Extraction

Unadulterated palm wine was bought at intervals from a local palm wine tapper at Ngwo-Agu, in Udi Local Government Area of Enugu state, Nigeria. The procured palm wine were immediately identified and authenticated as genuine *Elaeis guineensis* Sap at the department of Plant Science and Technology, University of Nigeria, Nsukka. Thereafter, the palm wine were then diluted with 50% clean tap water, and allowed to ferment at room temperature for 24 hours before being administered to the rats.

### Experimental animals

Twenty five (25) healthy male wistar rats with an average weight of 180g were procured from animal house facility of the University of Nigeria, Enugu campus. However, this study was carried out in the Animal facility of the Enugu State University of Science and Technology College of Medicine, Parklane, Enugu. The animals were kept in well-ventilated breeding rooms and housed in netted iron cages. They were provided easy access to food (normal rat chow) and tap water *ad libitum* and were also allowed to acclimatize for 2 weeks under standard laboratory conditions. Ethical approval was gotten from the university's ethical clearance committee with the ethical right permission number: ESUCOM/FBMS/ETR/17/001.

### Experimental Designs

The experimental procedure for this study lasted for 14 days. The experimental animals were divided into five groups (n=5) with average weight of 200g; Group A: Normal controls (n=5) were fed with normal rat chow and distilled water daily for fourteen days.

Group 2 to 5: The four experimental groups (n=5; Groups B, C, D, and E) were administered increasing volumes of palm wine via oral cannulas in progression of 1ml, 2ml, 4ml, and 8ml respectively, daily for 14 days (Oyedeji *et al.*, 2012).

### Animal Sacrifice and Tissue Removal

The total body weights of the experimental animals were noted on intervals (Day 1, 5, 10 and 15) using ESAL Spring Scale. 24 hours after their last administration (Day 15), the rats were sacrificed under ketamine (100mg/ml) as anesthesia. Their respective brain cavity was opened-up and the brain excavated, weighed via water displacement method to determine the total brain volume and then fixed in Bouin's fluid.

**Statistical Analysis**

The results of the brain weights (obtained by Simple Water Displacement method) and body weights (obtained by Spring Balance method) of the rats were analyzed using SPSS version 17, and the data were expressed as Mean ± Standard Deviation. Comparison of the mean body weights at day 1 and day 15, the change in mean body brain weights at day 15, and the % brain weight to body weight ratios at day 15 for the respective groups were recorded and presented in tables, charts and graph.

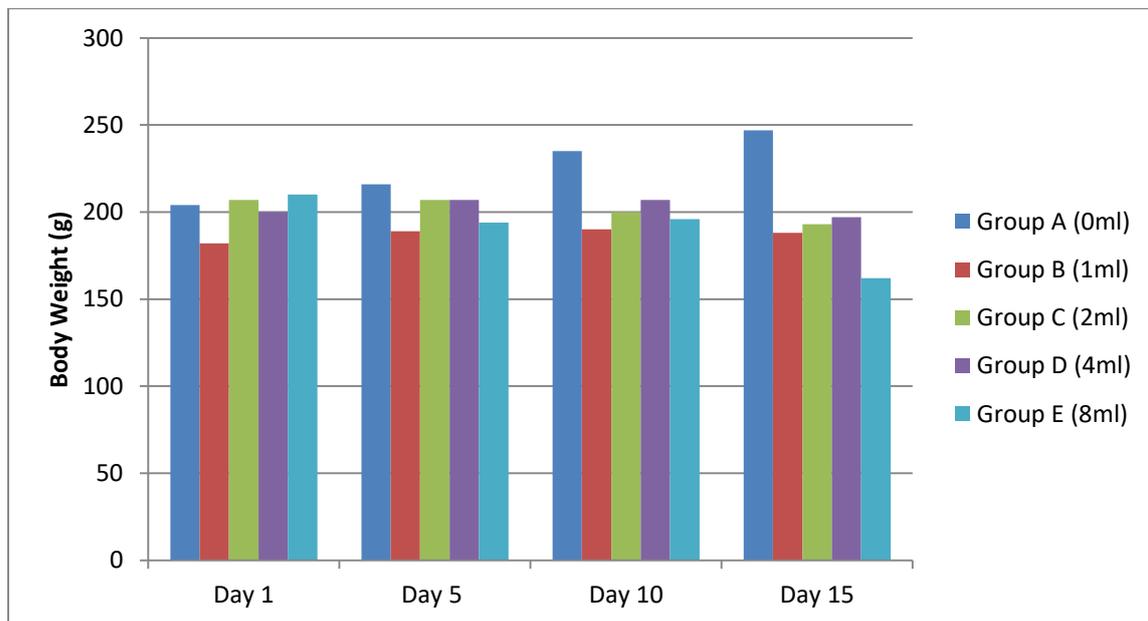
**3. RESULTS**

**Morphometric Analysis**

**Table 1: Showing the comparison of the respective mean body weights of rats in groups with different volumes of palm wine consumed at day 1, day 5, day 10, and day 15 respectively.**

Days	GROUP A 0ml (control)	GROUP B 1ml	GROUP C 2ml	GROUP D 4ml	GROUP E 8ml
	weight (g)				
day 1	204.0+10.8	181.6+2.2	207.1+16.1	200.0+9.4	210.1+11.6
day 5	216.1+12.1	188.5+6.5	207.0+17.2	207.0+15.2	194.1+31.4
day 10	235.0+12.7	190.0+11.2	200.5+17.9	206.5+18.0	195.8+14.1
day 15	246.6+15.6	188.0+15.7	192.6+23.9	197.4+15.1	161.8+10.1

Overall increase in body weights was noted in the control. However, experimental groups showed a mixed picture with some showing initial increment, and all showing a marked weight loss at the end of the experiment, worse with group E.



**Figure 1: Comparison of the respective mean body weights of rats in with the different volumes of palm wine consumed**

**Table 2: Showing the change in mean brain weights/volumes relative to the volumes of palm wine consumed.**

GROUPS	Volume of palm wine (ml)	Change in Mean brain weights (g)
A	0	2.9
B	1	3.03
C	2	3.06
D	4	3.1
E	8	3.6

Increase in overall mean brain weights noted in the experimental group relative to the control. This seems controversial as it is contrary to usual expectations of shrinkage with high intake of alcohol.

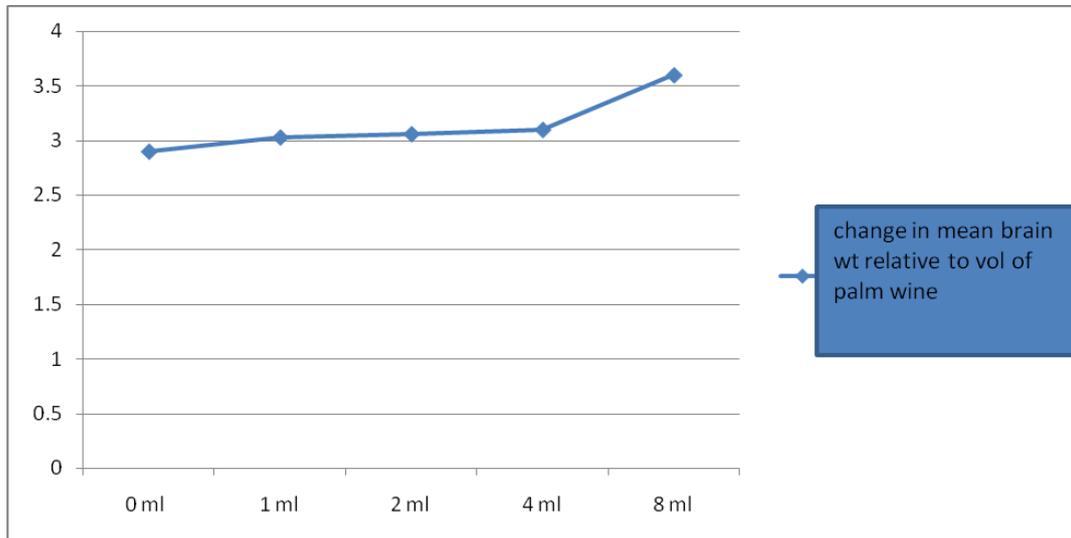


Figure 2: A graph showing the change in mean brain weights/volumes relative to the volumes of palm wine consumed

Table 3: Showing the comparison of the mean body weights at day 1 and day 15, the change in mean body and brain weights at day 15, and the % brain weight to body weight ratios at day 15 for the respective groups.

GROUPS	Mean Body weights(g) at day 1	Mean Body weights(g) at day 15	Change in mean body weights	Mean Brain weights(g) at day 15	%Brain weights/Bodyweights at day 15
A	204.0+10.8	246.6+15.6	42.6	2.90+0.10	1.2
B	181.6+2.2	188.0+15.7	6.4	3.03+0.12	1.6
C	207.1+16.1	192.6+23.9	-14.5	3.07+0.12	1.6
D	200.0+9.4	197.4+15.1	-2.6	3.10+0.53	1.6
E	210.1+11.6	161.8+10.1	-48.3	3.60+0.10	2.2

There is a relative decrease in mean body weights with a peak loss at day 15 in the experimental groups, in contrary to a marked increase in body weights for the control group.

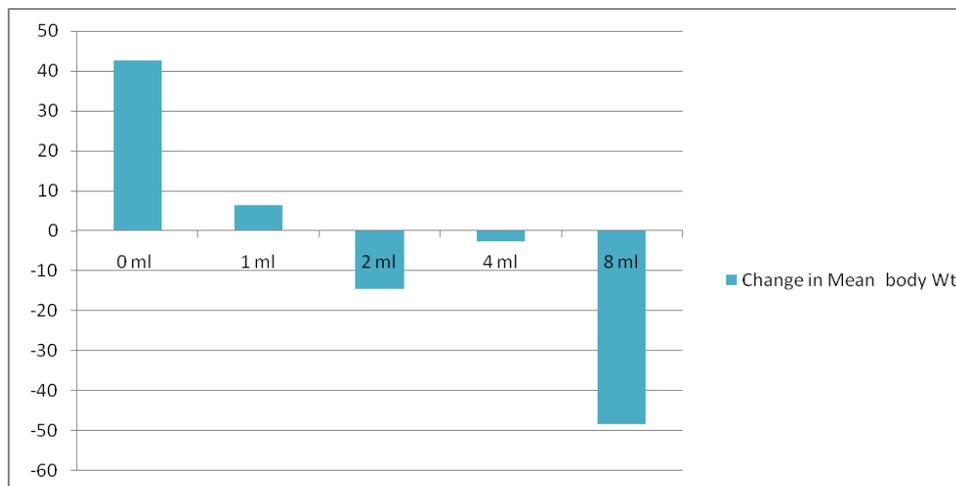


Figure 3: Bar chart showing the relationships between palm wine volumes (Horizontal plane) and change in mean body weights (Vertical plane) as shown in table 3.

#### 4. DISCUSSION

The sap from oil palm (*Elaeis guineensis*) notably called “palm wine” is a popular traditional alcoholic beverage commonly consumed by the multitude for either cultural, personal or ceremonial reasons among Nigerians including the Igbos of the South -Eastern region (Eluwa *et al.*, 2010). Oil palm (*Elaeis guineensis*) sap is known to have alcoholic contents of about 4.5-5.2gm/100ml after fermentation (Bassir, 1962; Osim *et al.*, 1991)

Detrimental effects of alcohol have previously been studied whereby alcohol affected body and brain morphometric parameters (Kril *et al.*, 1989; Cordain *et al.*, 1997; Breslow and Smothers, 2005 Paul *et al.*, 2008). This study thus, displayed similar findings.

An examination of the pre and post experimental weights showed an overall reduction in animal weights in palm wine treated groups in contrast to a relatively progressive weight gain observed in the control group. The pattern of weight change in the control (Group A) was peculiar in that it was constant, with change in mean body weight of 42.6g. This could have been physiological as the only substance they were exposed to was water and food *ad libitum*. The group that received 1ml of palm wine (group B) had a change in mean body weight of 6.4g, and this could be due to initial body adaptation to calories. However, the C, D, and E groups that received 2ml, 4ml, and 8ml of palm wine respectively, had the relative change in mean body weights of -14.5g, -2.6g and -48.3g respectively; these could be probably due to loss of appetite by the animals in these groups. It appeared emphatically as though the control group gained as much weight as the group E (that had the highest dose of palm wine; 8ml daily for 14 days).

This study meets conflicting literature which showed that effect of alcohol use on body weight may be nonlinear. Breslow and Smothers, (2005) noted that frequent light or moderate alcohol consumption is often associated with lower body weight. Those who regularly consume moderate amounts of alcohol are more likely to reduce their intake of other foods to balance the caloric increase from alcohol (Cordain *et al.*, 1997). High intensity drinkers (regardless of frequency) may be less likely than other drinkers to reduce their intake of other foods, potentially leading to weight gain (Istvan *et al.*, 1995; Breslow and Smothers, 2005).

Progressive increases in relative brain volumes were also noted. This tends to correlate with the known fact that alcohol impairs the ability to regulate the volume and composition of fluid and electrolyte in the body (Enoch, 1995), but seems to contrast with the general believe that heavy alcohol drinking shrinks the brain thereby causing total decrease in brain volume (Paul *et al.*, 2011), and also contrast with study by Pfefferbaum *et al.*, 1997 which suggests that Frontal lobes seem to be especially susceptible to volume loss following long-term chronic alcohol exposure. A study using stereology to monitor cell number demonstrated no significant cell loss through the neocortex, even though overall cortical volume was decreased, suggesting atrophy or dendritic retraction rather than frank cell death (Jensen and Pakkenberg, 1993). Significant reduction of soma size in frontal cingulate cortex of alcoholics, without a significant change in cell number, has also been observed (Harper and Kril, 1989). Changes in glial cell count following chronic ethanol exposure have also been reported and indicate decreases in both density and size of glia in dorsolateral PFC (Miguel-Hidalgo *et al.*, 2002) and orbitofrontal cortex (Miguel-Hidalgo *et al.*, 2006). Whether the loss of volume in alcohol-dependent subjects is reversible is still undetermined. In one study, subjects who were abstinent for 6–9 months after entering a rehab program showed decreased ventricle size, but there was no increase in frontal lobe volume when compared to their entry into the rehab program (Wobrock *et al.*, 2009).

Due to the method of measuring brain volume in this work which was based on volume of water displaced by brain in a beaker as against the advanced technologies such as magnetic resonance imaging (MRI), diffusion tensor imaging (DTI), positron emission tomography (PET), and electrophysiological brain mapping, and buttressed by the fact that there were progressive injuries to the brain with increased volumes of palm wine from 1ml, through 2ml and 4ml, to 8ml as evidenced by the histopathological findings (not included in this study), we assert, therefore, that the apparent increases in brain volumes could have been due to inflammation and increases in the ventricular and sulcal volumes, and not brain tissue. This correlates with two other studies that related alcohol consumption to ventricular and sulcal size; an inverse measure of brain atrophy (Ding *et al.* 2004).

## 5. CONCLUSION

The fermented sap from oil palm (*Elaeis guineensis*) notably called “palm wine” clearly demonstrated a dose dependant undesirable effect on the morphological parameters investigated. Higher doses relatively led to drastic reduction in total body weights and increased brain weights/volume of the experimental animals used.

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