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RESEARCH ARTICLE

STUDY OF THE ACUTE AND SUBACUTE TOXICITY OF A HYDROALCOHOLIC EXTRACT DERIVED FROM THE PULP OF THE RAPHIA SESE DE WILD FRUIT IN WISTAR RATS

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Abstract

Introduction:-The use of medicinal plants is very common in Africa, particularly in the Democratic Republic of the Congo, where the pulp of the fruit of *Raphia sese* De Wild. is used for nutritional and curative purposes. However, scientific details regarding its toxicity remain limited.

Objective:-This study aims to assess the acute and subacute toxicity of the fruit pulp extract of *Raphia sese* De Wild. in Wistar rats.

Materials and Methods:-We conducted an experimental study on Wistar rats, divided into groups receiving three doses of the extract (1000, 2000, and 5000 mg/kg) in a single administration to assess the effects of acute toxicity, followed by clinical observation over a 15-day period and body weight monitoring every three days. Regarding subacute toxicity, we administered the extract daily at doses of 250, 500, and 1000 mg/kg to the rats for 28 days. Hematological and biochemical analyses were performed to identify any potential toxic effects associated with consumption of the extract, in accordance with the guidelines of the Organization for Economic Cooperation and Development.

Results:-The results showed no mortality or clinical signs of toxicity. No significant changes were observed in hematological parameters ($p > 0.05$). Biochemical indicators for the liver and kidneys remained stable, confirming the absence of organ toxicity. However, a notable decrease in blood glucose levels ($p < 0.05$) was observed in the groups that received treatment.

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Conclusion:-The pulp extract of the *Raphia sese* De Wild fruit exhibits low toxicity and good tolerance in Wistar rats. It could constitute a potential source of bioactive compounds with hypoglycemic effects.

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Introduction:-

Medicinal plants play a crucial role in healthcare systems, particularly in developing countries. The use of plants is an essential part of healthcare management for approximately 80% of the world's population (World Health Organization, 2013). This reliance is attributed to the availability, low cost, and sociocultural acceptability of medicinal plants (WHO, 2013). Among plant species of interest, the fruit pulp of *Raphia sese* De Wild., belonging to the Arecaceae family, is widely abundant in Central Africa, particularly in the Democratic Republic of the Congo. This pulp is used for both food and medicine. Several studies have confirmed its use in treating certain metabolic, infectious, and inflammatory diseases (Burkill, 1995; Neuwinger, 2000); however, despite its widespread use, there remains a lack of scientific data on the safety of this pulp.

However, assessing the toxicity of plant extracts is a crucial step in justifying their therapeutic use. Indeed, as Claude Bernard and later Paracelsus pointed out, "every substance is toxic; only the dose makes the poison." This means that even certain plants considered to be safe can have harmful effects at certain doses. Acute and subacute toxicity studies in laboratory animals, particularly rats, allow for the testing of a substance's potential short- and medium-term effects and the determination of lethal doses as well as possible physiological changes (OECD, 2001; OECD, 2008). Such tests are essential to ensure the safety of plant use before validating their therapeutic applications in humans. In this context, this study aims to evaluate the acute and subacute toxicity of the fruit pulp extract of *Raphia sese* De Wild in rats and to contribute to the scientific validation of its use as well as the development of this local plant resource.

Materials and Methods:-**Materials:-****Plant Material:-**

The samples of *Raphia sese* De Wild fruit pulp from the city of Gungu (Kwilu Province) used in this study were purchased at the NGABA market in the commune of the same name in the city-province of Kinshasa, DRC. *Raphia sese* De Wild has the nomenclatural number 33138 in the eFlore / Tela Botanica database published by Emile Laurent in 1905. The pulp was air-dried at room temperature, then ground into a fine powder using an electric grinder.

Preparation of the extract:-

The resulting powder was subjected to hydroalcoholic extraction (80% ethanol). Approximately 600 g of powder was macerated in 6 L of solvent for 72 hours with regular agitation. The mixture was filtered, then concentrated using a temperature-controlled rotary evaporator (60 °C). The resulting extract was dried in an oven at 50 °C for 48 hours and then stored in the laboratory at room temperature until use.

Animal Materials:-

A total of 40 albino Wistar (*Rattus norvegicus*), aged 8 to 10 weeks and weighing between 100 and 150 g, with an equal distribution of males and females, were obtained and used for an experiment at the INRB (National Institute of Biomedical Research in Kinshasa). They were kept in plastic cages lined with wood shavings at the bottom, topped with a metal mesh cover allowing them access to water bottles and food. The rearing temperature averaged 22°C, and the photoperiod (day and night/light and darkness) was normally maintained.

Ethical Considerations:-

The experimental procedures were conducted in accordance with the Organization for Economic Cooperation and Development (OECD) guidelines for animal testing, specifically Guidelines 423 (acute toxicity) and 407 (subacute toxicity). Ethical approval, numbered 87/CBE/ISTM/KIN/RDC/PMBBL/2025, was granted by the Bioethics Committee of the Institut Supérieur des Techniques Médicales de Kinshasa (ISTM/Kin), an institution supporting our training.

Methods:-**Acute toxicity study (14 days):-**

The acute toxicity assessment was conducted in accordance with OECD Guideline 423 (acute toxicity class method). A total of 20 rats were divided into 4 cages of 5 animals each and were administered the extract orally at increasing doses of 1000, 2000, and 5000 mg/kg body weight, respectively, for the first, second, and third cages; the fourth cage, serving as the control group, received the solvent (20% methanol) based on each animal's body weight.

These rats were monitored for the first 24 hours, then daily for 14 days to detect:

- Clinical signs of toxicity (tremors, lethargy, diarrhea, convulsions);
- Mortality,
- Behavioral changes.

Body weight was measured every three days. The LD50 was estimated based on the observations.

Subacute toxicity study (28 days):-

The subacute toxicity study was conducted in accordance with OECD Guideline 407. The animals were divided into 4 cages of 5 rats each:

- Test cage 1: 250 mg/kg
- Test cage 2: 500 mg/kg
- Test cage 3: 1000 mg/kg
- Control cage 4: administration of the solvent (20% methanol) based on each animal's weight.

The extract was administered orally daily for 28 days.

Parameters studied:-

Clinical parameters:-

- Observation of general behavior
- Food and water intake

Hematological parameters:-

At the end of the experiment, blood samples were collected to analyze the complete blood count, which includes:

- Hemoglobin (Hb)
- Hematocrit (HCT)
- Red blood cells (RBC)
- White blood cells (WBC)
- Platelets
- White blood cell differential (WBCD)
- Mean Corpuscular Volume (MCV)
- Mean Corpuscular Hemoglobin (MCH)
- Mean Corpuscular Hemoglobin Concentration (MCHC)

Biochemical parameters:-

The following markers were evaluated:

- Urea
- Creatinine
- Blood glucose
- Serum glutamyl-oxaloacetate transaminase (SGOT)
- Serum glutamic-pyruvic transaminase (SGPT)
- Total protein
- Total cholesterol
- HDL cholesterol
- Triglycerides
- LDL
- Alkaline phosphatase (ALP)

Statistical analysis:-

Data are expressed as mean \pm standard deviation. Statistical analysis was performed using SPSS version 25. Comparisons between groups were performed using analysis of variance (ANOVA). A p-value < 0.05 was considered statistically significant.

Results:-**Results of the acute toxicity test:-****Table I: Changes in body weight by dose**

Cages	Day 0 (fasting)	Day 3	D6	D9	Day 12	Day 15
1000 mg/kg	110.6 \pm 13.2	131.8 \pm 12.5	139.6 \pm 12.6	146.0 \pm 14.2	146.4 \pm 13.8	148.2 \pm 19.0
2000 mg/kg	96.2 \pm 14.0	124.6 \pm 20.5	115.0 \pm 12.0	128.4 \pm 14.8	132.6 \pm 13.4	129.0 \pm 18.5
5000 mg/kg	92.0 \pm 2.4	101.8 \pm 8.6	119.0 \pm 6.7	127.6 \pm 9.5	134.1 \pm 12.5	133.8 \pm 8.0
Solvent (Control)	108.8 \pm 18.3	97.0 \pm 10.8	137.2 \pm 21.2	136.6 \pm 20.5	143.4 \pm 17.2	142.2 \pm 23.1

This table shows an overall increase in body weight across all groups with no dose-dependent decreasing trend, with greater variation observed in the 2000 mg/kg group and the control group.

Table II: Comparison of body weights between groups (1000, 2000, 5000 mg/kg, and control)

Cages	Day 0 (fasting)	D3	D6	D9	Day 12	Day 15
1000 mg/kg	110.6 \pm 13.2	131.8 \pm 12.5	139.6 \pm 12.6	146.0 \pm 14.2	146.4 \pm 13.8	148.2 \pm 19.0
2000 mg/kg	96.2 \pm 14.0	124.6 \pm 20.5	115.0 \pm 12.0	128.4 \pm 14.8	132.6 \pm 13.4	129.0 \pm 18.5
5000 mg/kg	92.0 \pm 2.4	101.8 \pm 8.6	119.0 \pm 6.7	127.6 \pm 9.5	134.1 \pm 12.5	133.8 \pm 8.0
Solvent (Control)	108.8 \pm 18.3	97.0 \pm 10.8	137.2 \pm 21.2	136.6 \pm 20.5	143.4 \pm 17.2	142.2 \pm 23.1
F	1.48	2.05	1.72	1.33	1.09	1.12
p-value	0.26	0.14	0.20	0.30	0.38	0.37
Interpretation	NS	NS	NS	N/A	NS	NS

Analysis of variance (one-way ANOVA) revealed no significant differences between the cages on the various observation days ($p > 0.05$). On day 15, the F-value ($F = 1.12$; $p = 0.37$) confirmed that administration of the fruit pulp extract of *Raphia sese* De Wild had no significant effect on the body weight of the animals.

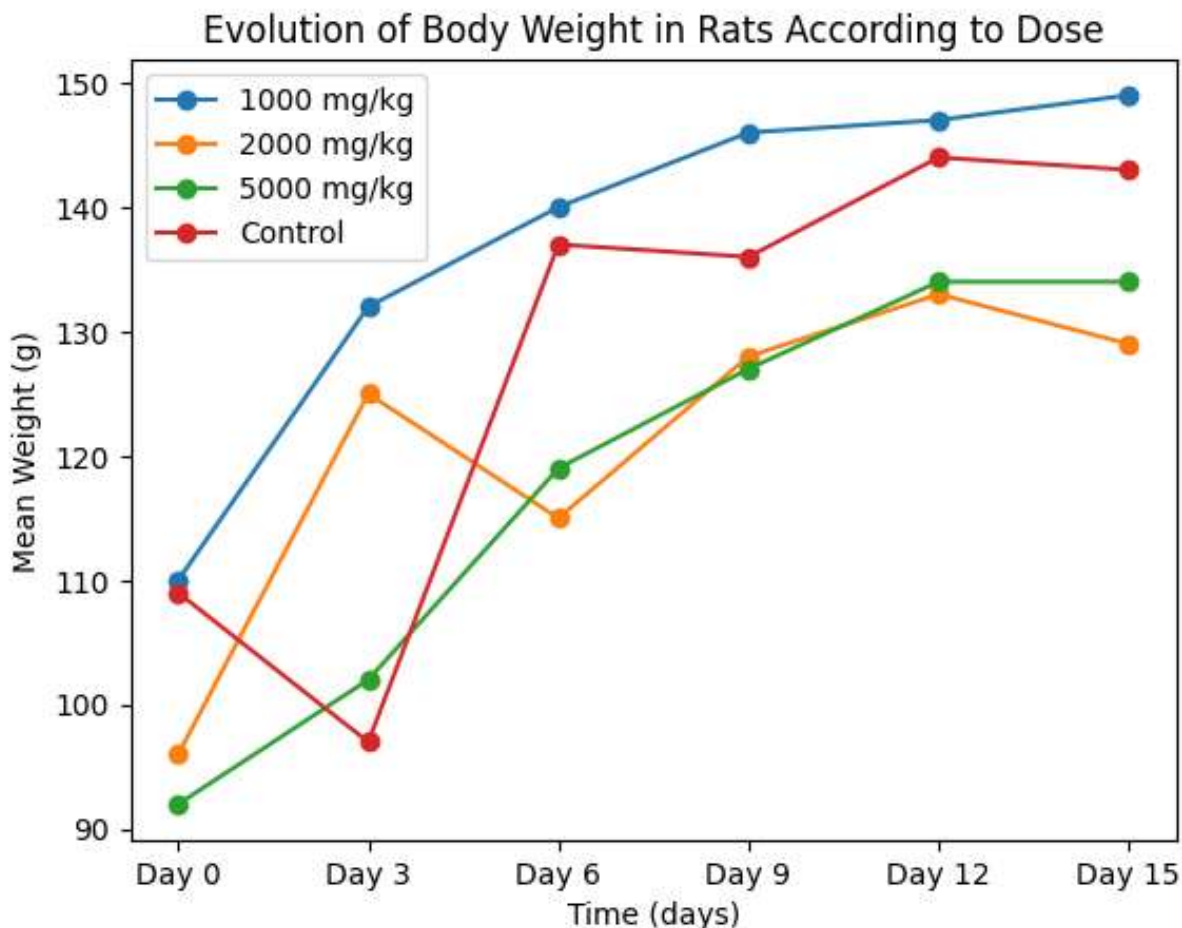


Figure 1: Changes in body weight of rats over time and according to doses of *Raphia sese* De Wild.

The curve shows a gradual increase in body weight in all experimental cages. No significant difference was observed between the treated cages and the control cage, confirming the toxic effect on weight gain.

Results of the subacute toxicity test:-

Hematological results:-

Table III: Distribution of hematological indices according to administered doses

DOSES ADMINISTERED	Hematological parameters									
	Hb	Hct	GR	GB	PLATELETS	FL N	FL L	VGM	TCMH	CCMH
250 mg	9.4	25	5.58	2,300	404,000	22	78	45	16.8	37.4
	12.7	32	6.95	3,000	1,280,000	14	86	45.6	18.2	40.1
	12.1	31	6.77	4,000	1,253,000	13	87	46.1	17.8	38.7
500 mg	13	33	6.78	6,500	7,370,000	19	81	48.3	19.1	39.7
	12.4	32	6.81	6,900	1,613,000	20	80	46.2	18.2	39.8
	12.7	32	6.82	6,500	8,930,000	17	83	47.4	18.6	39.3
1000 mg	13.2	33	7.23	7,900	1516000	14	86	45.4	18.2	40.2
	13.4	34	7.35	4,900	1,338,000	18	83	45.9	18.2	39.7
	12.7	33	7.02	4,800	8,430,000	19	81	46.7	18	38.8
Solvent	9.4	25	5.47	4,700	600,000	21	79	45.9	17.1	37.4

	8.3	23	4.91	3,700	360,000	25	75	47.7	19.9	35.4
	8.9	24	5.2	4,200	480,000	23	77	46.8	18.5	36.4

Erythrocyte parameters:-**Table IV: Analysis of variance (ANOVA) of erythrocyte parameters according to administered doses**

Hematological parameters	Changes in the means of hematological parameters						
	250 mg	500 mg	1000 mg	SOLVENT	Snedecor's F-test	p-value	Significance
Hemoglobin (g/dL)	11.4±1.8	12.7±0.3	13.1±0.4	8.87±0.55	12.07	0.0027	S
Hematocrit (%)	29.33±3.8	32.33±0.6	33.33±0.6	24 ±1	13.14	0.0017	S
Red Blood Cell	6.43±0.8	6.8 ± 0.02	7.2 ± 0.17	5.19±0.28	13.52	0.0015	S
VGM	45.57 ± 0.67	47.3 ± 1.06	46 ± 0.67	46.8 ± 0.9	2.56	0.12	NS
TCMH	17.6 ± 0.70	18.63 ± 0.5	18.13 ± 0.1	18.5 ± 1.4	0.939	0.46	NS
CCMH	38.73 ± 1.40	39.60 ± 0.3	39.57 ± 0.7	36.4 ± 1.0	7.61	0.008	S

The results for erythrocyte parameters show a slight decrease in hemoglobin, hematocrit, and red blood cells in some cages, particularly in the 250 mg/kg cage. However, these variations are not dose-dependent and are also observed in the control cage. This lack of a dose-response relationship suggests that the observed changes are not attributable to the administration of *Raphia sese* De Wild fruit pulp extract. Furthermore, erythrocyte indices (MCV, MCH, MCHC) are generally within normal limits, indicating the absence of regenerative or deficiency anemia.

Leukocyte parameters:-**Table V: Analysis of variance (ANOVA) of leukocyte parameters according to the administered doses**

Hematological parameters	Changes in the means of hematological parameters						
	250 mg	500 mg	1000 mg	SOLVENT	Snedecor's F-test	p-value	Significance
White Blood Cell	3100±854	6633±231	5866.67 ± 1800	4200 ± 500	7.42	0.01	S
FL N	16.33 ± 4.93	18.67 ± 1.5	17 ± 2.7	23 ± 2	2.87	0.096	NS
FL L	83.67 ± 5.61	81.33 ± 1.5	83.33 ± 2.5	77 ± 2	2.56	0.12	NS

Data on leukocyte parameters show that some cages exhibit mild leukopenia, particularly in the cage that received the low dose. Nevertheless, a trend toward normalization or even an increase in white blood cells was observed at doses of 500 and 1000 mg/kg. These observations may reflect an adaptive mechanism of the organism in response to administration of the extract. Furthermore, the leukocyte profile remained dominated by lymphocytes, which is physiologically normal in rats (Suckow et al., 2006). The absence of significant changes in leukocytes suggests that the extract does not induce immunotoxicity.

Platelets:-**Table VI: Analysis of variance (ANOVA) of platelet counts according to administered doses**

Hematological parameters	Changes in the means of hematological parameters						
	250 mg	500 mg	1000 mg	SOLVENT	Snedecor's F-test	p-value	Significance
Platelets	979,000 ± 495	5,971,000 ± 388	3,761,333 ± 40	480,000 ± 1,200	1,403,000	<0.0001	S

Platelet counts showed significant variation between cages; this variation was not related to the administered dose. Overall, the hematological results show that administration of the fruit pulp extract of *Raphia sese* De Wild. has no significant impact on blood values in Wistar rats. The absence of statistically significant differences and dose-dependent effects indicates favorable hematological tolerance to the extract at the doses analyzed.

Biochemical results:-**Table VII: Distribution of biochemical indices according to administered doses**

DOSES ADMINISTERED	Biochemical parameters										
	UREA	CREAT	GLY	SGOT	SGPT	PRO T	CHOL	HDL	TRIG LY	LDL	PAL
250 mg	71	0.9	110	198.2	80	8	74	24	26	45	499
	19	0.8	90	194	77.3	7.7	54	11	39	35	756
	80	0.8	73	222.9	77.8	8.2	75	22	86	36	885
500 mg	85	0.9	21	272.7	89.6	9.3	67	5	70	48	746
	61	0.6	72	184.4	80.2	8.5	76	4	77	57	256
	172	0.8	80	226.8	96.7	9.1	103	4	87	86	635
1,000 mg	139	0.9	62	190.8	103.7	9.1	113	7	11	104	552
	65	0.7	43	186.4	91.7	7.1	69	8	90	43	815
	50	0.8	42	226.4	87.5	8.9	91	7	119	60	853
Solvent	40	0.8	109	267.3	56.7	8	55	8	28	40	621
	39	1	179	153.1	64.1	9.3	84	10	94	8	697
	39.5	0.9	144	210.2	60.4	8.7	69.5	9	61	24	659

Renal function:-**Table VIII: Analysis of variance (ANOVA) of renal function according to administered doses**

Biochemical	Changes in the means of biochemical parameters						
	250 mg	500 mg	1000 mg	SOLVENT	F-test SNEDOCOR	p-value	Significance
Urea	56.67 ± 32.9	106.00 ± 58	84.67 ± 47.6	39.5 ± 0.71	1.54	0.28	NS
Creatinine	0.83 ± 0.1	0.77 ± 0.2	0.80 ± 0.1	0.9 ± 0.14	0.668	0.59	NS

Renal parameters, particularly urea and creatinine, showed no statistically significant differences between the treated cages and the control cage ($p > 0.05$). Although a non-significant increase in urea was observed at certain doses, the absence of a dose-response relationship suggests biological variability rather than renal damage.

Blood glucose:-**Table IX: Analysis of variance (ANOVA) of blood glucose levels according to administered doses**

Biochemical	Changes in the means of biochemical parameters						
	250 mg	500 mg	1000 mg	SOLVENT	F-test of SNEDOCOR	p-value	Significance
Blood glucose	91±18.5	57.67 ± 32	49.00 ± 11.3	151.00 ± 37.1	8.95	0.006	S

We observe a significant reduction in blood glucose levels in the cages that received the extract at different doses ($p < 0.05$) and a dose-dependent trend. This marked reduction compared to the control cage demonstrates that the extract has a hypoglycemic effect.

Liver parameters:-**Table X: Analysis of variance (ANOVA) of liver parameters according to administered doses**

Biochemical	Changes in the means of biochemical parameters						
	250 mg	500 mg	1000 mg	SOLVENT	F-test of SNEDOCOR	p-value	Signi Catio n

SGOT	205.03 ± 16	227.97 ± 44	201.20 ± 21.9	210.2 ± 80.8	0.183	0.91	NS
SGPT	78.37 ± 1.4	88.83 ± 8.3	94.30 ± 8.4	60.4 ± 5.2	15.89	0.001	S
Alkaline phosphatase	713.33 ± 197	545.67 ± 256.9	740 ± 164	667.67 ± 33.4	0.672	0.59	NS

For the liver enzymes SGOT and SGPT, no significant differences were observed between the cages ($p > 0.05$). Although SGPT values were slightly elevated in the cages receiving high doses, they remained within limits consistent with normal liver function.

Lipid profile:-

Table XI: Analysis of variance (ANOVA) of the lipid profile according to the administered doses

Biochemical	Changes in the means of biochemical parameters						
	250 mg	500 mg	1000 mg	SOLVENT	F-test SNEDOCOR	p-value	Significance
Cholesterol	67.67 ± 11.8	82.00 ± 18.7	91 ± 22	69.5 ± 20.5	1.04	0.42	NS
HDL cholesterol	19.00 ± 7	4.33 ± 0.6	7.33 ± 0.6	9 ± 1.4	9.38	0.005	S
Triglycerides	50.33 ± 31.6	78.00 ± 8.5	73.33 ± 55.9	61 ± 5.0	0.294	0.83	NS
LDL cholesterol	38.67 ± 6	63.67 ± 19.7	69.00 ± 31.5	40.33 ± 26.6	1.387	0.32	NS

Analysis of the lipid profile revealed no significant changes ($p > 0.05$), although a slight increase in total cholesterol and LDL was observed at high doses. However, these changes remain insignificant and could be related to normal metabolic fluctuations (Nguenang et al., 2021).

Total protein:-

Table XII: Analysis of variance (ANOVA) of total protein according to administered doses

Biochemical	Changes in the means of biochemical parameters						
	250 mg	500 mg	1000 mg	SOLVENT	F-test SNEDOCOR	p-value	Significance
Total protein	7.97 ± 0.3	8.97 ± 0.4	8.37 ± 1.1	8.65 ± 0.9	0.943	0.46	NS

Total protein levels remained stable across all cages, indicating good nutritional status and preserved liver function, given that the liver plays a key role in protein synthesis (Tietz, 2012). Analysis of biochemical parameters indicates that the extract of the fruit pulp of *Raphia sese* De Wild does not induce hepatic or renal toxicity in Wistar rats. However, the significant decrease in blood glucose levels suggests a potential hypoglycemic effect of the extract. Overall, the absence of significant variation for the majority of parameters ($p > 0.05$) indicates good systemic tolerance.

Discussion:-

The assessment of plant extract toxicity is based on an approach that integrates the examination of hematological, biochemical, clinical, and weight parameters to comprehensively evaluate a substance's safety (OECD, 2001; Nguenang et al., 2021). In this study, administration of the fruit pulp extract of *Raphia sese* De Wild caused neither mortality nor severe clinical signs of toxicity, even at the maximum dose of 5000 mg/kg, indicating low acute toxicity. This observation is confirmed by the animals' weight gain, which showed a gradual increase in the majority of cages that received the extract. A key sign of tolerance is the absence of significant weight loss, given that a reduction in body weight is usually associated with a toxic effect or a metabolic disturbance (Raza et al., 2002). Furthermore, the absence of a statistically significant difference between the cages ($p > 0.05$) confirms that the extract did not affect the animals' growth. From a hematological perspective, the collected data indicate that erythrocyte levels (red blood cells, hemoglobin, hematocrit) generally remained within the physiological range, although some non-dose-dependent fluctuations were observed, which were also noted in the control cage. These variations may be attributed to physiological or experimental factors and do not reflect direct toxicity of the extract.

According to Girkins and Clifford (2008), the consistency of erythrocyte indices is a reliable indicator of the integrity of erythropoiesis. Furthermore, leukocyte parameters and the leukocyte differential count revealed no notable abnormalities, indicating the absence of immunotoxicity. These observations are consistent with those of Suckow et al. (2006), who report that the observed lymphocyte predominance is typical in rats.

These observations are confirmed by biochemical analysis. Indeed, liver parameters (SGOT, SGPT, and alkaline phosphatase) showed no significant difference between the cages treated with the extract and the control cage ($p > 0.005$), indicating the absence of hepatic cytolysis. According to Claude Bernard, these enzymes serve as sensitive indicators of hepatocyte integrity, and their stability reflects satisfactory hepatic tolerance. As noted by Blaine et al. (2015), renal parameters (urea and creatinine) generally remained stable, indicating preserved renal function. However, a significant decrease in blood glucose levels ($p < 0.005$) was noted in the cages that received the extract, indicating a potential hypoglycemic effect of the extract. This observation is particularly intriguing, as it could explain the traditional use of this pulp in the treatment of certain metabolic diseases. Akomolafe and Orivomi (2024) also reported similar results, highlighting the antidiabetic properties of certain plant extracts rich in bioactive compounds. Furthermore, the lipid profile and total protein levels showed no notable changes, suggesting that there is no disruption of lipid metabolism or hepatic synthetic function. According to Tietz (2012), stable total protein levels indicate good liver function and overall metabolic balance.

The overall results, characterized by the absence of significant dose-dependent changes for most of the analyzed parameters ($p > 0.05$), indicate that the observed variations are due to normal biological fluctuations rather than extract-induced toxicity. These findings support the research by Fokou et al. (2022), who reported low toxicity in species of the genus *Raphia*. The pulp extract exhibits minimal toxicity and is well tolerated in Wistar rats, according to hematological, biochemical, and weight data. Furthermore, the absence of significant variations in most of the parameters examined, combined with normal weight gain, indicates that the extract does not cause major adverse effects. The hypoglycemic effect observed to date shows promising potential for therapeutic applications. Furthermore, the use of methanol as an extraction solvent does not appear to be the cause of the reduced toxicity observed. Despite methanol's intrinsic toxicity, it is usually removed during the concentration and drying phases of the extract. In the event of incomplete evaporation, residues could potentially increase toxicity rather than reduce it (OECD, 2008). Consequently, within a strict experimental framework, the low toxicity observed reflects the plant's intrinsic characteristics rather than the influence of the solvent used.

Conclusion:-

This study was conducted to evaluate the acute and subacute toxicity of *Raphia sese* De Wild extract in Wistar rats. The results show that administration of this extract at the various tested doses did not result in mortality or major clinical signs of toxicity during the experimental period. Analysis of hematological parameters revealed no significant changes, with values generally falling within physiological ranges. The observed difference, notably mild anemia in some cages, including the control cage, showed no dose-response relationship, suggesting that it is not attributable to the extract. Biochemically, liver markers (SGOT, SGPT, and alkaline phosphatase) and renal markers (urea and creatinine) showed no significant differences between the cages receiving the extract and the control cage ($p > 0.005$), indicating the absence of hepatic or renal toxicity. Nevertheless, a significant reduction in blood glucose levels ($p < 0.005$) was observed, indicating a possible hypoglycemic effect of the extract. Furthermore, the results of the lipid profile and total protein analysis corroborate the extract's good metabolic tolerance. Overall, these results indicate that the extract from the studied pulp exhibited low toxicity and good systemic tolerance in Wistar rats at the experimental doses.

The low toxicity observed in the pulp extract under study is likely due to its phytochemical profile, which is dominated by low-toxicity compounds such as flavonoids and polyphenols. Methanol, used as the extraction solvent, is not responsible for this low toxicity, as it is removed during the extract concentration process. Thus, the good tolerance observed in Wistar rats suggests a wide safety margin for this pulp. These results provide a scientific basis for the traditional use of the pulp under study and open up interesting prospects for its application in the development of phytomedicines, particularly in the management of metabolic disorders such as diabetes.

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