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Effects of *Ananas Comosus* Juice and Physical Exercise on Biochemical and Inflammatory Parameters in Obese Women of Yaounde-Cameroun

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Abstract
This study aims to evaluate the effects of Ananas comosus juice and physical exercise on biochemical and inflammatory parameters in obese women. 40 obeses women were subjected to the experiment for 60 days. After randomization, they were divided into experimental (GA, GS, GAS) and control (GC) groups. Each group consisted of 10 participants. Measurements of different parameters were carried out at before and the end of exercice.
The results showed that the consumption of Ananas comosus juice as well as the physical exercises induced various variations in the experimental groups.
In GA we observe that the total cholesterol (TC), LDL-c, triglycerides (TGR), decreased ($p<0.001$; 42.66%; 68.15%, 39.45%). Conversely, HDL-c increased ($p<0.01$; 133.62%). In terms of GS women, the following variables suffered a decrease ($p<0.001$): TC (38.18%) and LDL-c (67.72%). But, HDL-c (125.33%) showed an increase ($p<0.001$). In GAS, we have observed that TC, LDL-c, CRP decreased ($p<0.001$; 38.75%; 69.67%; 23.32%), and HDL-c ($p<0.001$; 122.61%) increased.
The consumption of Ananas comosus and/or the pratice of physical exercises had positive effects on the risk factors related to obesity, but the associated treatment seems more efficacious than the treatments in isolation.
Key words: *Ananas comosus, exercises, obesity, biochemical, inflammatory parameters Cameroon.*

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I. Introduction

Obesity is recognized as a major public health problem. It is currently one of the leading risk factors for death in the world (OMS, 2003). Approximately 3.4 million adults die from obesity each year. According to the WHO, in some African urban areas, obesity rates are close to 30% in the adult population. In Cameroon, several studies have established the variation of the prevalence of this disease in different socio-professional groups. In 1998, the prevalence was 39.58% among women in the city of Yaoundé (Ngogang et al, 1988). It is 33.3% in the village of Foto in the west of Cameroon (Etoundi et al, 2001). In 2010, the number of people affected by obesity was estimated at 44% (Nono et al, 2010).

Many reasons could induce corpulence, but the main cause is the combination of many consumption of high energy foods and lack of physical activity (Swinburn et al, 2004). However, it should be noted that obesity is also associated with many pathologies such as type 2 diabetes in 80% of cases, hypertension, excess lipids in the blood, cardiovascular damage, respiratory diseases, as well as joint diseases (AICR, 2018). Dietary treatment, consumption of certain fruits and regular physical activity can reduce some risk factors related to obesity (Ahounou et al, 2020 ; Ouilliot et al, 2010). Some studies have shown that the consumption of *Ananas comosus* associated with regular exercise has positive effects on anthropometric parameters, hemodynamics and lipid profile in obese people (Hamadou et al, 2017 ; Xie et al, 2014). Therefore, it would be interesting to study the combined effects of *Ananas comosus* juice consumption and exercise on biochemical and inflammatory parameters in obese women.

Moreover, the associative treatment has more effects on measured parameters compared to the consumption of Ananas comosus juice and practice of physical exercises carried out in isolation. This study

aims to evaluate the effects of consumption of raw Ananas comosus juice and the practice of physical exercises on biochemical and inflammatory parameters in obese women. Specifically, the aim is to determine which treatment has a greater effect on these parameters.

II. Methods

2.1 Plant material

The plant material used was the fruit of "*Ananas comosus*", harvested in the field in the Mbankomo area located in the Central Region of Cameroon and more precisely in the Mefou and Akono Department. This fruit will be used to make juice. It was chosen because it is the most widespread variety among the cultivars exploited in Cameroon (FAO, 2009) and is available in the markets throughout the year. This plant is identified in the national herbarium in Yaoundé, where a specimen is kept under number 18648/SRF/CAM.

2.2 Participants

40 sedentary obese women were selected for the experiment. They were shared in four (04) groups of ten (10) women:

-control group (GC) have not praticed physical exercises and have not consumed *Ananas comosus* juice ;
- *Ananas group* (GA) brings together women who have consumed only *Ananas comosus* juice ;
-Sport group (GS) was those of women who have practiced only physical exercises;
-*Ananas* + sport group (GAS) has practiced physical exercises and consumed *Ananas comosus* juice.

2-2-1- Inclusion criteria

Women selected on a non-random, reasoned-choice basis. They were sedentary obese women. Their age varies between 40 and 60 and they had signed a written informed consent according to the principles of the Helsinki Convention (1974)

2-2-2- Exclusion criteria

The participants excluded from the experiment are those who practiced less than two thirds of the physical exercise sessions and those having been ill during the experiment.

2.3 Equipment

- A centrifuge brand YOVA Juice Extrafor YV-100 was used for grinding and filtering *Ananas comosus* juice.
- A refrigerator LG Express cool GTF 272G was used for the conservation of *Ananas comosus* juice.
- An Accu-Chek® Active blood glucose meter was used to measure blood glucose levels.
- A CYAN Start spectrophotometer was used to read the optical densities (DO) of the samples, the standard and the cholesterol, triglyceride and CRP kits, for their assays.

2.4 Protocole

The program of physical exercise is structured in two mesocycles of four microcycles each. The duration of a mesocycle is 30 days.

The duration of microcycle is one week to four sessions. Each session lasts 45 to 90 minutes and the intensity of the physical exercise ranged from 55 to 70% of the maximum heart rate with periods of passive and active recovery per exercise. The sports practice program has a total number of 32 sessions. This program, designed for sedentary adults and for practical and control reasons, was furnished with aerobic endurance activities, anaerobic endurance activities, and flexibility exercises. The physical exercises were done at the beginning in the form of a split effort (intermittent) and ended with a continuous effort. The samples were taken between 6:30 a.m. and 9:30 a.m. Assessments were performed at the beginning and end of the experiment to evaluate changes in the variables.

After being sorted, washed and peeled, the fruits are crushed and filtered in a centrifuge, then the raw juice was made between 6 and 7 am and distributed immediately to the participants. The rest is bottled and kept in the refrigerator at 4°C. The juice was consumed between 8 and 9 am and/or between 12 and 1 pm. It should be consumed in no more than two intakes and one hour before a meal. An amount of 750 ml was consumed daily for 60 days.

Total cholesterol, HDL-cholesterol and triglycerides are measured with SGM italia kits. The LDL-cholesterol level is calculated using the Friedewald formula.

LDL-cholesterol (mg/dL) = Total cholesterol - HDL-cholesterol - [(Triglycerides)/5]

Blood glucose was measured in the fasting state using an Accu-Chek glucose meter. The blood glucose value in mg/dl is displayed 5 seconds later on the reflectometer screen. The CRP determination was performed on heparinized plasma by immunoturbidimetric method on Cobas ® 6000 from Roche Diagnostic.

2.5 Statistical analysis

The data collected was organized using MS Excel 2010 software, which allowed for the observation of central tendencies and dispersion characteristics such as the mean and standard deviation. R software version 3.2.3 was used to perform statistical tests, including the Wilcoxon Test that was performed to compare the mean values of the parameters obtained at the beginning and end of the experiment. The comparison of effects between treatments required the implementation of an analysis of variance (ANOVA) with the treatment as a fixed factor. The difference between two means is significant if $P < 0.05$.

III. Results

3.1 Biochemical parameters

Blood lipid and blood glucose levels at the beginning and end of the human experiment are recorded in Table 1.

Consumption of *Ananas comosus* juice during 60 days of experimentation significantly ($p < 0.01$) reduced total cholesterol (36.80%), LDL-cholesterol (38.95%) and triglycerides (28.76%). However HDL-cholesterol increased significantly ($p < 0.01$; 133.62%). The practice of physical exercises significantly influenced ($p < 0.01$) the decrease of total cholesterol (40.00%), LDL-cholesterol (44.94%) and triglycerides (28.56%), while that of HDL-cholesterol increased by 139.93% ($p < 0.01$). The combination of *Ananas comosus* juice consumption and physical exercise during 60 days of experimentation had very significant effects ($p < 0.01$) on blood lipid levels. In fact, total cholesterol, LDL-c and triglycerides decreased respectively: 45.09%; 56.97 and 37.30%, while the HDL-cholesterol level increased by 157.41%. Blood glucose, decreased ($p < 0.05$; 11.94%).

Table 1: Mean values of atherogenic blood lipid and blood glucose levels in obese women.

	GA		**GS**		**GAS**		**GC**	
Parameters	**Before**	**End**	**Before**	**End**	**Before**	**End**	**Before**	**End**
CT (mg/dL)	290.01 ± 90.26	183.26 ± 38.84	275.91 ± 61.54	165.54 ± 12.20	289.71 ± 34.45	159.06 ± 12.80	264.36 ± 104.78	293.11 ± 88.38
Δ (%)	**-36.80****		**-40.00****		**-45.09****		**10.87***	
HDL (mg/dL)	31.38 ± 6.17	73.33 ± 13.28	34.26 ± 10.32	82.20 ± 16.47	34.48 ± 6.20	88.77 ± 14.79	39.90 ± 13.66	38.14 ± 1.42
Δ (%)	**133.62****		**139.93****		**157.41****		**-4.41^{NS}**	
LDL (mg/dL)	219.85 ± 97.61	134.21 ± 32.00	218.45 ± 60.99	120.27 ± 30.63	223.77 ± 38.54	96.27 ± 31.97	199.53 ± 112.84	211.59 ± 93.08
Δ (%)	**-38.95****		**-44.94****		**-56.97****		**6.04^{NS}**	
TRG (mg/dL)	214,05 ± 71,96	152,48 ± 32,11	201.99 ± 32.70	144.30 ± 18.48	197.93 ± 39.33	124.09 ± 35.50	198.10 ± 34.03	226.92 ± 67.13
Δ (%)	**-28.76****		**-28.56****		**-37.30****		**14.54^{NS}**	
Gly (mg/dL)	93.1 ± 16.57	90 ± 13.72	83.4 ± 12.08	84.3 ± 18.42	82.9 ± 12.02	73 ± 13.91	92.5 ± 26.07	98.5 ± 26.41
Δ (%)	**-3.32^{NS}**		**1.07^{NS}**		**-11.94***		**6.48^{NS}**	

Δ: variation; %: pourcentage; HDL: Hight density lipoprotein; LDL: Low density lipoprotein, TRG: triglycerides; Gly: blood glucose: GA : group ananas ; GS : group sport ; GAS : group ananas + sport GC : group control *: $p < 0,05$; **: $P < 0,01$; NS : non significative

3.2 Inflammatory parameter

The mean values of C-reactive protein at the beginning and end of the experiment are recorded in Table 2.

Table 2: Mean values of CRP

Parameter	GA		GS		GAS		GC	
	Before	**End**	**Before**	**End**	**Before**	**End**	**Before**	**End**
CRP	23.35±10,79	20.1±8.80	21.01±11.62	17.68±8.78	21.62±12.07	16.58±9.96	22.42±12.68	24.06±12.95
Δ (%)	**-13.92***		**-15.85***		**-23.32*****		**7.31***	

Δ: variation; %: pourcentage; CRP : C – réactive – protein ; GA : group ananas ; GS : group sport ; GAS : group ananas + sport GC : group control *: p < 0,05; **: P < 0,01; NS : non significative

3.3 Intergroup comparison

- **Final average values of blood lipid levels**

After experimentation, the analysis of the final values of blood lipid levels shows that the consumption of *Ananas comosus* juice alone, as well as the practice of physical exercises alone and their combination had similar effects on the variables total cholesterol; LDL-cholesterol; HDL-cholesterol and triglycerides. These results are illustrated in fig 1, 2, 3 and 4.

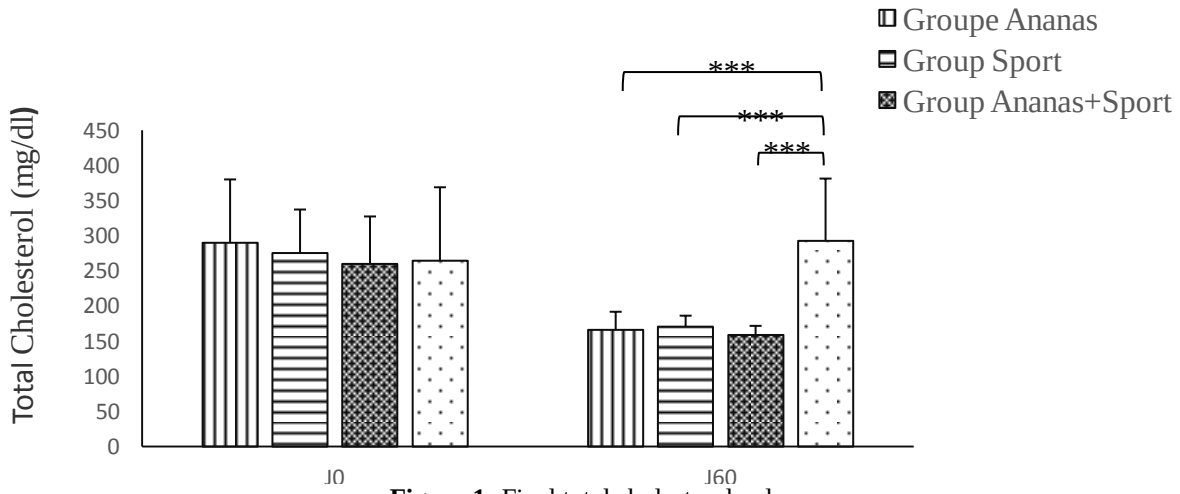

Figure 1: Final total cholesterol values

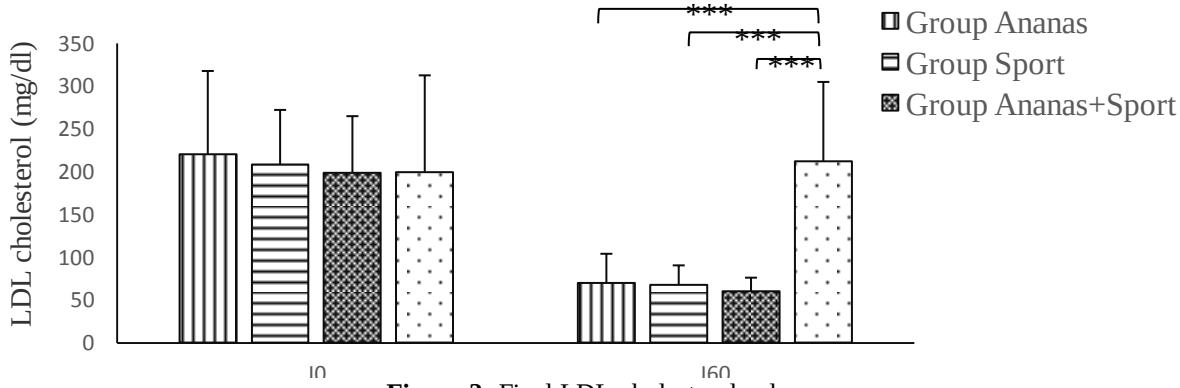

Figure 2: Final LDL-cholesterol values

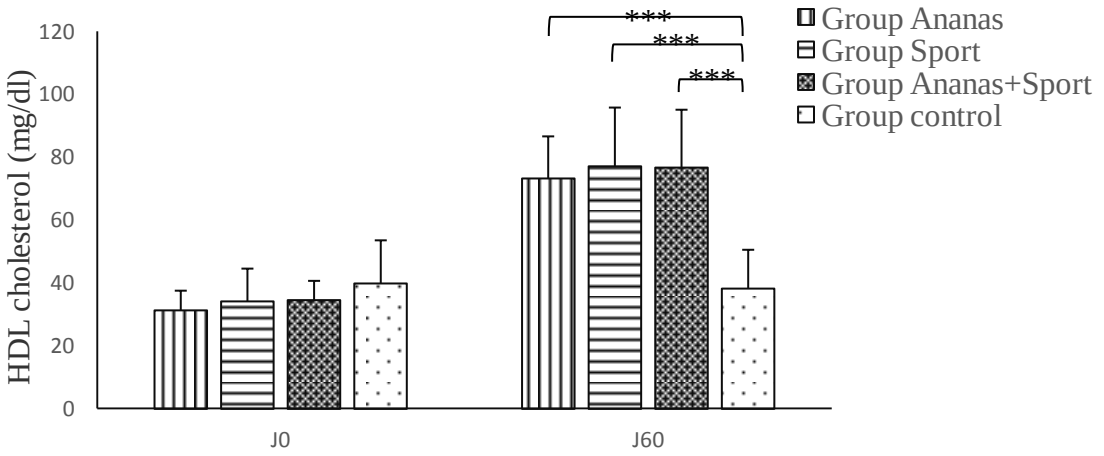

Figure 3: Final HDL-cholesterol values

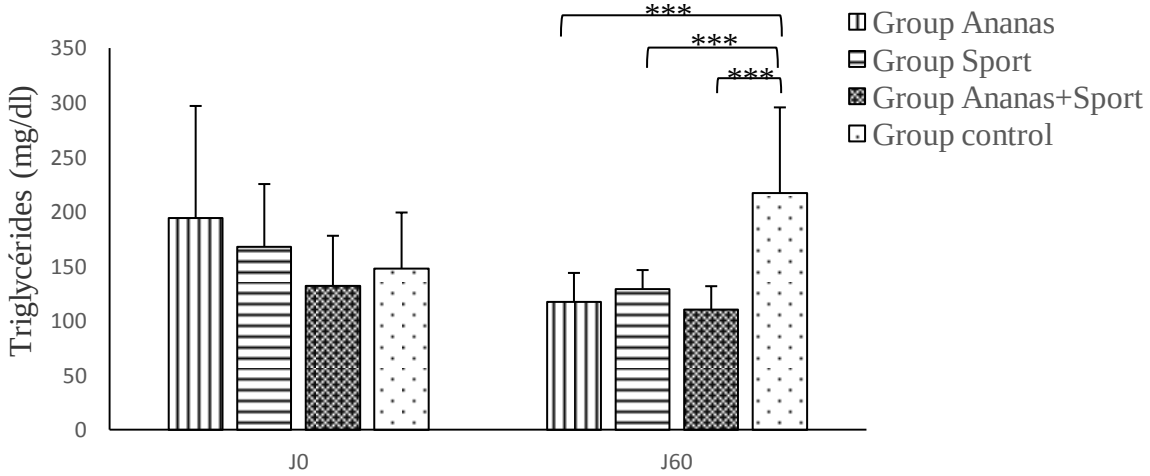

Figure 4: Final values of triglycerides

3.4 Final mean blood glucose values

At the end of the study, the observation made of the final blood glucose values shows a significant decrease ($p<0.05$) was observed only between the GAS and the positive control group. This result is illustrated in Fig 5.

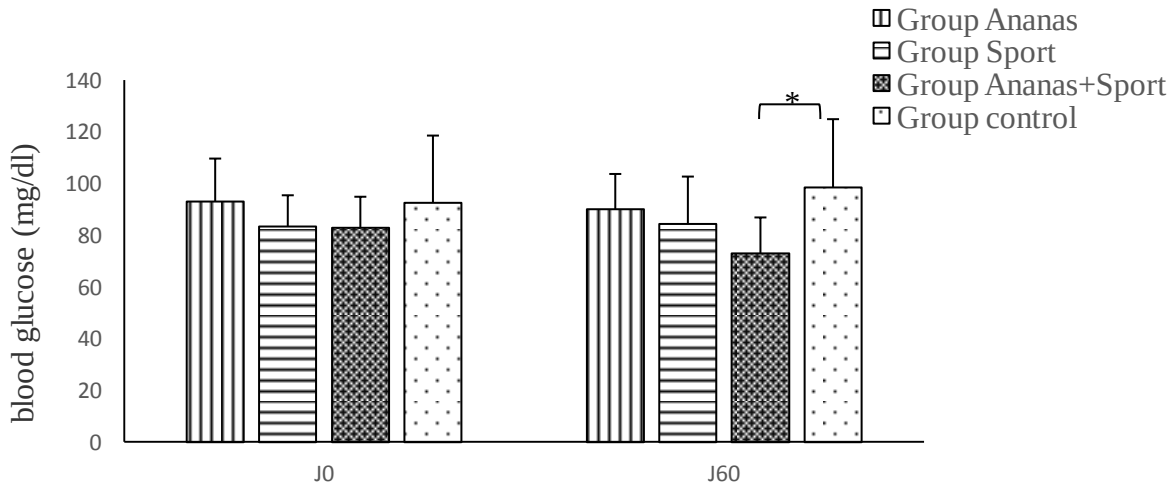

Figure 5 : Final blood glucose values

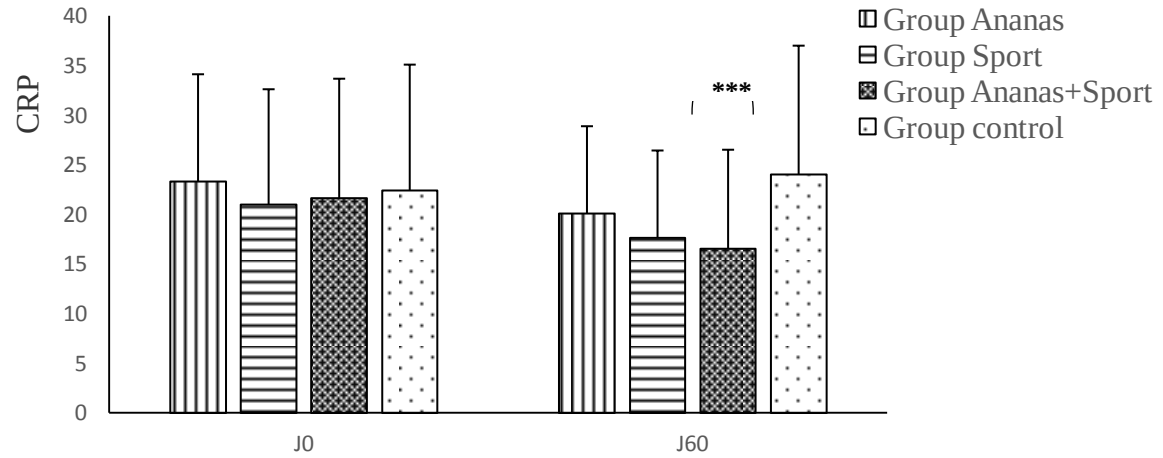

Figure 6 : Final CRP values

3.5 Final mean values of c-reactive protein

A significant decrease ($p<0.05$) was observed on the final values of C-reactive protein. The result is shown in fig 6.

IV. Discussion

The objective of this study was to evaluate the effects of the consumption of raw *Ananas comosus* juice and physical exercise on biochemical and inflammatory parameters in obese women. At the end of the experiment, the results showed that total cholesterol, LDL-c and triglycerides decreased significantly ($p < 0.01$) in all groups with various rates of change. These decreases can be attributed to the different treatments that the participants underwent. The beneficial effect of *Ananas comosus* juice on blood lipid levels correlated with obesity observed in the group of participants who consumed raw *Ananas comosus* juice could be explained by the presence of bromelain and dietary fiber in *Ananas comosus*. Our results corroborate those of the literature. Indeed, bromelain would improve the circulatory and cardiovascular systems (Ley et al, 2011; Maurer, 2001) and would inhibit platelet aggregation (Ley et al, 2011), therefore purifying the blood. As for dietary fiber, several studies have shown its effects on reducing hypercholesterolemia in humans (Derbré, 2010).

The favorable effects of physical activity on lipid disorders in obese adults have been demonstrated by several authors. Thus, the observation of the lipidic parameters in the participants who practiced physical activity showed a significant decrease ($p < 0.01$) of total cholesterol (40%), LDL-C (44.94%), triglycerides (28.56%) and an increase in HDL-C (139.93%). The beneficial effects of exercise on the variation of blood lipids would be explained by an increase in activity of lipoprotein lipase, partly related to the increase in capillary density in the muscle (Stefanick et Wood, 1994). Similarly, regular physical activity characterized by high energy expenditure also decreases triglyceride levels and may influence, total and LDL cholesterol levels. The triglycerides decreases, especially if physical activity is accompanied by weight normalization or loss . Our results are in agreement with the literature (Camhi et al, 2009).

The comparison of the results between the study variables in the different groups shows that the percentages of variation are higher in the subjects who consumed the *Ananas comosus* juice and practiced the physical activity. These more pronounced variations would be due to the cumulative effects of the two treatments, namely *Ananas comosus* juice and physical exercises.

At the beginning of protocol, the average blood glucose values of our participants were considerably normal. At the end of the experiment, although there were decreasing variations in all experimental groups, no value was below normal. However, a significant ($p < 0.05$) decrease in blood glucose was observed in subjects who consumed *Ananas comosus* juice and practiced the physical activity. These modulations of blood glucose levels could be explained by isolated or associated actions (Bertrais et al, 2005). Several authors have demonstrated the beneficial effects of physical exercise in diabetic subjects (Cuff et al, 2003), which improves glycemic homeostasis in a global way and limits the risk of hypoglycemia. Indeed, the mechanisms of action of physical activity on blood glucose are multiple. Firstly, it increases the content, transcription and number of GLUT-4 receptors (Boclé et al, 2005) thus leading to a better uptake of glucose by the non-insulin-dependent pathway. Secondly, physical activity potentiates the use of glucose by oxidative pathway by increasing the number and size of mitochondria and activity of hexokinase (Kim et al, 2004). Finally, physical activity would lead to an increase in capillarization around type 1 fibers that are very sensitive to insulin action and large users of free fatty acids, thus favoring the supply of energy substrates and the action of insulin (Boclé et al, 2005). Our

results are related to those of previous authors. Even if the decrease in blood sugar was not significant in participants who consumed only *Ananas comosus* juice, we observe at least that this product remarkably decreased blood sugar in obese people contrary to the idea that the consumption of pineapple juice would promote the increase of blood sugar because of its sweet taste. We believe that this product would have potentiated physical activity thanks to its content of dietary fiber, energy substrates and vitamin B1 and C (Mercier et al, 1999) thus leading to a remarkable decrease in blood glucose levels. Indeed, dietary fibers are carbohydrate polymers (polysaccharides) of plant origin, bound or not to lignin or other non-carbohydrate polymers. They can also be transformed or synthetic carbohydrate polymers. They are, therefore, hydrophilic molecules with the capacity to trap water. They have the particularity of being neither digested nor absorbed in the small intestine and present at least one of properties in increase in stool production; stimulation of colonic fermentation; decrease in fasting cholesterol levels and decrease in postprandial glycemia and/or insulin levels (Derbré, 2010 ; Lebeau et al, 2009).

Analysis of the results on the level of inflammation in *Ananas comosus* group (GA) showed that CRP was significantly reduced. This result is consistent with those, who have shown that bromelain has long been known to regulate the digestive enzymes responsible for inflammation in order to benefit from better digestion (Kerkhoffs et al, 2004).

In GS, a very significant decrease in c-reactive protein was observed. This result corroborates with the literature, as regular exercise acts on the visceral adipose tissue and causes the production of numerous peptide and cytokine substances by the muscle tissue itself. These myokines have different functions, they are involved in the control of muscle mass, in the mobilization and oxidation of fatty acids, angiogenesis, endothelial functions (Pedersen, 2017). Similarly, IL-6 plays a special role in inflammation. It is produced by the muscle depending on the intensity of exercise, but also depending on the metabolic conditions of the muscle (John et al, 2003).

V. Conclusion

The objective of this study was to evaluate the cumulative effects of pineapple juice consumption and physical exercise on biochemical and inflammatory parameters in obese women. After 60 days of pineapple juice consumption and physical exercise, changes were observed on the study variables. Indeed, total cholesterol, LDL-c and triglycerides decreased in all experimental groups. On the other hand, HDL-c increased. However, the percentages of variation are higher in the group of participants who consumed the juice and practiced the physical exercises compared to those who received the isolated treatments. These data suggest that the combination of pineapple juice and exercise had more positive effects on the causal factors of obesity.

Furthermore, these results combined with the reduction in blood glucose and CRP in the pineapple + exercise group suggest the possibility of developing new nutritional and athletic treatment protocols to reduce the adverse effects of obesity.

The daily consumption of 750 ml of pineapple juice associated with the practice of physical exercises of at least 45 min duration, of an intensity ranging between 55 and 70% of the FCmax with a frequency of 04 sessions seems to be an effective strategy to fight against the risk factors related to obesity.

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Conflict of Interest:

No potential conflict of interest was reported by the authors.

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