PhD Thesis Summary

INFLUENCE OF DRY FOOD ON SOME BIOCHEMICAL AND HEMATOLOGICAL PARAMETERS IN DOG

SCIENTIFIC COORDINATORS

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PhD THESIS SUMMARY

INTRODUCTION

Increasing number of larger dogs as pets and extremely dynamic and sometimes stressful life of dog owners, directed the latter to find the most efficient and fastest way to ensure a balanced and more manageable diet for their pet. Food that can achieve this goal is the dry granulated food. Currently, there is a whole industry in this area, which offers an extremely wide range of dry feed. Dry food for dogs must correspond from a nutritional point of view, be appropriate to the species, age and reproductive status of the animal.

Water is one of the key ingredients as it serves as a vehicle for substances, influence nutrient digestion and excretion of metabolites. It acts as a solvent for many bioactive substances, act in the control of temperature and take part in the hydrolysis of essential biochemical reactions in the body. It is also very important for the optimal functioning of the skin. The main ingredient of dry pet food is raw meat, which by its proteins are an important source of nitrogenous substances with a particular biological value. Biological value depends mainly on the content of essential amino acids. Fat from meat, in addition to energy intake, assure also the essential fatty acids: linoleic, linolenic, arachidonic. Through the content substances present or formed during storage and thermal processing, meat promotes the secretion of gastric juices massively stimulating digestion.

For choosing the correct type of food, the pet owner will have to follow the right criteria: the convenience of administration, cost and nutritional philosophy, which is defined by the composition, palatability and texture of the food. An adequate diet for a healthy dog should assure and to maintain an ideal body condition.

The purpose of this study was to monitor and interpret how dry food affects some hematological and biochemical constituents in dogs. The dogs were subjected for 12 months to a food diet. This diet consisted of mixed food prepared in home, dry food containing 18 % protein and 8 % fat and dry food containing 30 % protein and 22 % fat.

At the same time we intend to identify by medical imaging exams and histopathology, functional or structural changes in the liver and kidneys, knowing that these organs respond first in the case of monotonous food diet.

The main objectives of the thesis were:

• establishing groups of work;
• to identify parameters that best reflect altered hepatic and renal functions and altered physiological status;
• monitoring of biochemical and hematological parameters;
• statistical evaluation of biochemical and hematological parameters of each group during the 12 months period;
• statistical evaluation of biochemical values changed during the 12 months period;
• ultrasound and radiological monitoring of abdominal cavity in the study dogs;
• removal of liver tissue by ultrasound-guided biopsy and histopathological examination of taken tissue;

**Structure of the thesis:** The thesis is composed of two main parts, first part is called bibliographic study and the second part is called personal research. The second part includes materials and methods, results and discussion related to each chapter.

The first part includes three chapters (1-3):

**CHAPTER I - PHYSICAL AND BIOCHEMICAL QUALITY REQUIREMENTS FOR DRY FOOD FEED TO DOGS AND CATS** - briefly describe the quality and sanitation issues in dry food administered to dogs and cat. Also in this chapter are assessed qualitative aspects of dry food components.

**CHAPTER II - MINIMUM FOOD REQUIREMENT FOR MAINTAINING HEALTH IN DOGS** describes the importance and impact of various components contained in dry food upon animal organism.

**CHAPTER III - SIGNS OF DEFICIENCY OF ESSENTIAL NUTRIENT. NUTRITIONAL STATUS ASSESSMENT METHODS** compile certain nutritional deficiencies characteristic clinical signs in dogs and cats, and related tests required for evaluation and diagnosis of these deficiencies. Chapter III presents the metabolic change due to metabolic deficiencies encountered in liver and kidney disorders, and principles of management of these conditions.

The second part contains four chapters (4-7):

**CHAPTER IV - SCOPE AND OBJECTIVES** detail the requirements of this chapter.

**CHAPTER V - MATERIAL AND METHODS** mention the number of cases studied and systematize them into 3 groups according to the feed given. Group I considered the control group was fed with mixed food, food prepared in the household, group II was fed dry
food containing 18% protein and 8% fat and group III, which was fed with dry food containing 30% protein and 22% fat. It describes the working methods used and the equipment.

CHAPTER VI - RESULTS AND DISCUSSION. Described the experimental model and statistical evaluation of biochemical parameters studied. Statistical calculation was used to assess progress in the evaluated biochemical parameters during the 12 months period and to compare biochemical parameters that showed changes between the three groups. The results obtained for each group were correlated statistically with results obtained in imaging exam and hystopathological findings.

CHAPTER - CONCLUSIONS systematize the findings obtained by carrying out studies based on statistical calculation.

The thesis has 237 pages, Part I - Bibliographic study comprises of 64 pages representing 27.48% of the total work; Part II - Researches comprises of 169 pages representing 69.96% of the total work and 21 pages representing 2.56% of the total work is the table of contents and index for figures, charts and tables.

Summary

The experimental design used to group the 30 dogs studied, in three groups of 10 dogs each: group I was the control group fed with mixed food prepared in the home, group II was fed dry food containing 18% protein and 8% fat and the third group was fed with dry food with a content of 30% protein and 22% fat.

To monitor the influence of diet on some biochemical and hematological constituents, blood was collected at 1 month, 2 months, 3 months, 4 months, 6 months, 8 months and 12 months respectively after the start of the experiment.

Statistical calculation took into account the assessment of biochemical change occurring in evaluated constituents, for each group during those 12 months. For monitoring of biochemical parameters in time, it was used the ANOVA with repeated measures test, applying the necessary corrections to avoid type II error if it does not meet the criteria for sphericity. Evaluation of sphericity assumed equal differences between the analyzed groups or rather the homogeneity of covariance. This was performed using the Mauchly test. For evaluation of intra-group correlation using repeated measures ANOVA test was used the post-hoc Bonferroni correction.

For statistical evaluation between the values of biochemical constituents in the 3 groups was used One Way ANOVA test. This test was used to compare values that have
experienced changes during the 12 months period. Evaluation of variance was performed using the Lavene test. If the assumption of equal variances was met it was applied Tukey post-hoc test for multiple comparisons. When not applicable, Welch ANOVA test and Brown-Forsythe ANOVA test for equal variances were administered, after which was applied the post hoc Games-Howell test for multiple comparisons.

**Statistical evaluation of the data obtained in group I**

Biochemical parameter values are within the normal range, except GPT, alkaline phosphatase, glucose and urea which are increases above the maximum physiological limit.

GPT values fall in the first two months (from $57.8 \pm 1.78$ to $53.9 \pm 0.83$ U / L), a statistically significant decrease ($p = 0.006$). In the 3rd month, GPT value shows increasing ($57 \pm 1.18$ U / L), without showing statistical significance versus 1st month. Since 4th month the GPT value presents significant decrease ($18.78 \pm 0.79$ U / L), but it showing an increasing trend from 6th month until 12th month ($28.6 \pm 1.5$ U / L), in this period values are located within physiological limits. Mixed food administration causes changes in biochemical parameters after 3 months from the start of administration (Chart 1).

Alkaline phosphatase level is elevated over the physiological limits throughout the 12 months period, but present a decline trend that begins with the first month of administration of mixed food and keep up to the 12th month (from $750.00 \pm 1.18$ U / L after the first month to $156.90 \pm 0.83$ U / L in the 12th month). Obvious decrease in alkaline phosphatase is between 3-4 months. The decreasing trend of alkaline phosphatase is statistically significant ($p = 0.000, p < 0.05$) and evident throughout the monitoring period. These high values can be placed on the bone isoenzyme, since the animals were young (Chart 1). Elevated GPT and alkaline phosphatase are correlated with hepatic fatty infiltration caused due to biliary drainage deficiency and anemia due to parasitic occult background. Changes in GPT values are relatively mild (between 53-57 U / L) and they are back within physiological limits ($0-55$ U / L) after 4 months of administration of mixed food.
The glucose values are located at maximum physiological range (62-110 mg / dl) in the early months of the administration of mixed food, associated with the increasing trend of cholesterol they suggest high caloric intake and probably an increased amount of crude fiber in the diet. After 3 months of mixed food feeding, glucose levels are within the physiological range of the species (Chart 2).

Urea values shows a decrease from the first month after administration of mixed food, to the 3rd months (from 32.60 ± 0.91 mg / dl in the first month at 28.20 ± 0.87 mg / dl in the 3rd month), decrease statistically significant (p<0.05). In the 4th month is observed a statistically significant (p = 0.007) increase in the urea. From the 4th month, the urea values present positive and negative oscillations, and in the 8th month urea values are elevated (31.00 ± 1.18 mg / dl, p = 0.470), but no statistical significance is evident. Values exceeding the maximum urea level are seen in the first month, in the 4th and 8th months from the start of mixed food administration. In the 12th month the mean values of urea is back within physiological limits (Chart 2).
Hematological examination in group I reveals a slight decrease in MCV (from $58 \pm 1.15$ to $57 \pm 1.02 \mu^3$) relative to the reference value $(60-77 \mu^3)$ and hematocrit (from $35.69\pm1.26\%$ to $32.48\pm1.87\%$) relative to the reference value $(40-55\%)$ and an increase of lymphocytes (from $4.90 \pm 0.58$ to $5.76 \pm 0.43$ mii/mm$^3$) compared to the reference value $(1-4.8$ mii/mm$^3$) and MCHC (from $35.41 \pm 2.01$ g / dl to $38.61 \pm 1.09$ g / dl), registering a slight neutropenia and lymphocytosis in 7 individuals. These values can be placed on low consumption of liquid and mild anemia.

Biochemical examination was correlated with hystopatologic examination performed on the liver biopsy, and ultrasound. By ultrasound was evaluated liver and kidney.

**Statistical evaluation of the data obtained in group II**

Biochemical parameter values are within the normal range, except for triglycerides, alkaline phosphatase, GGT, GPT and urea which are increased above the maximum physiological limit.

The amount of triglycerides is increasing within 8 months after administration of food with 18 % protein and 8 % fat (from $88.50 \pm 1.20$ mg / dl to $158.90 \pm 1.04$ mg / dl), a statistically significant increase ($p < 0.001$). At 6$^{th}$ months from the start of the administration, triglyceride exceeds the physiological value, maintaining the increased up to 8$^{th}$ month, there is no statistically significant obtained at 6$^{th}$ month ($p = 1$), but a statistical significance is observed compared to the values obtained in the start of the monitoring. After 8 months the value of triglyceride falls back within the normal range ($148.20\pm0.75$ mg / dl, $p<0.001$) (Chart 3).

The administration of food with 18 % protein and 8 % fat results in an increase in alkaline phosphatase, beginning with the first month (from $618.30 \pm 1.00$ U / l at the first month to $714.70 \pm 4.00$ U / l in 3$^{rd}$ month). Obvious decrease in alkaline phosphatase is between 3-4 months ($334.10 \pm 3.24$ U / L). After the 4$^{th}$ month, the amount of alkaline phosphatase recorded moderate growth which is maintained until the 12$^{th}$ month ($416.90\pm1.70$ U / L). The influence of food with 18 % protein is apparent from month 2 ($p<0.001$). Biochemical values obtained in group II are generally higher than the biochemical parameters obtained in group I. These values can be attributed on the basis of increased values of bone isoenzyme of alkaline phosphatase, since the animals were young (Chart 3).
GGT values shows growth from the 2\textsuperscript{nd} month, rising values are to be recorded also in the 3\textsuperscript{rd} months (11.00 ± 0.77 U / L after first and the second month to 13.20 ± 0.87 U / L in 3\textsuperscript{rd} month), statistically significant (p = 0.005). From the 4\textsuperscript{th} month, the GGT decreases (11.10 ± 0.83 U / l), being statistically insignificant (p = 1). Between 6-12 months, the GGT recorded two statistically significant increase in the 6\textsuperscript{th} month (13.40 ± 0.66 U / l, p < 0.001) and in the 12\textsuperscript{th} months (12.90 ± 0.83 U / l, p = 0.001). Between 1-12 months GGT values exceed physiological limits, significant changes are visible at 3 months, 6 months and 12 months after the start of administration of food with 18% protein and 8% fat.

Urea present growth starting in the 2\textsuperscript{nd} month, growth is maintained until the 6\textsuperscript{th} month (from 28.70 ± 0.90 mg / dl in the first month to 51.50 ± 1.20 mg / dl in the 6\textsuperscript{th} month), statistically significant increase beginning from 2\textsuperscript{nd} month (p < 0.05). Since the 8\textsuperscript{th} month, urea value slightly decreases to the 12\textsuperscript{th} month (51.00 ± 1.10 mg / dl). Urea values in the 6-12 months interval is statistically irrelevant relative to the values obtained at 4 months (p = 1). Urea values are exceeding the maximum limit at the 2\textsuperscript{nd} month, remaining high throughout the administration of food with 18 % protein and 8 % fat (Chart 4).
GPT values drop in the first two months (from 66.80 ± 2.23 to 56.10 ± 1.45 U/l, p<0.001). At 3rd month, the GPT increase, that is maintained until the 6th month (from 57.30 ± 1.49 U/l to 66.90 ± 1.37 U/l, p<0.001) being significantly statistical at 6th month. Beginning from the 8th month, GPT value shows significant decrease (62.80 ± 1.54 U/l, p<0.001), this decrease is highlighted also at 12th month (60.30 ± 1.85 U/l, p<0.05). GPT values exceed normal limits throughout the 12 months period. GPT values show statistical significance between 1-4 months and 8-12 months after the start of administration of food with 18% protein and 8% fat.

Elevated triglycerides, GGT, urea and GPT during the administration of food with 18% protein and 8% fat, associated with cholesterol increasing trend suggests a high caloric intake and possibly an increased amount of crude fibres in the diet, associated with a slight reactivity of the biliary channels and cholestasis due to a transient mild fatty infiltration of the liver parenchyma. Increased hepatobiliary enzymes GGT and GPT are minimal, they are present in high amounts in the cell cytosol and the increase values are probably due to their release into the bloodstream after cell lysis, or can be correlated with inflammation in the digestive tract. The GPT half-time is 2.5 days on average, increase in GPT can thus be identified after the disappearance of the primary cause. GOT values shows a very slight increase, and are not identified in all individuals, this is due to the short half-time of 22 hours. Stronger growth in GPT values are due to the fact that it is in larger quantity at the cellular level. This increase is made and based on occult intestinal parasitism. Note that some individuals were diagnosed with ascaris parasites (Chart 5).

Hematological examination in group II reveals a slight decrease in the number of red blood cells (from 5.49 ± 0.47 to 5.38 ± 0.27 mil/mm³) compared to reference values (5.5 -8.5 mil/mm³), hemoglobin (from 11.78 ± 0.47 g / dl to 10.91 ± 0.89 g / dl) compared to the reference values (12-18 g / dl), MCV (from 59.20 ± 1.47 to 58.97 ± 1.02 μ³) and hematocrit
(from 32.04 ± 1.23 % to 31.02 ± 1.05 %) and an increase of lymphocytes (from 6.03 ± 1.41 to 6.28 ± 1.31 mii/mm³) and MCHC (from 35.14 ± 1.11 g / dl to 36.15 ± 1.21 g / dl), there is recorded mild neutropenia and lymphocytosis and also mild anemia. These values may be based on low consumption of liquid.

**Statistical evaluation of the data obtained in group III**

The values of biochemical parameters in group III are located in the normal range, except for triglycerides, alkaline phosphatase, GGT, urea, GOT, GPT and ISE -Na with increases values above the maximum physiological range. The administration of food with 30 % protein and 22 % fat causes changes in biochemical parameters within the first month, changes which are more evident after 3 months from start of administration. Biochemical values obtained in group III are generally higher than the biochemical parameters obtained in group I.

Triglycerides are increased in the first six months of administration (from 69.20 ± 1.60 mg / dl to 177.50 ± 1.50 mg / dl ) being statistically significant (p < 0.001 ). Starting from 3rd month, the triglycerides exceed the physiological limit, maintaining high value also at 12th months. Between 8-12 month triglycerides value decreases (174.20 ± 1.17 mg / dl, p< 0.001). High values of triglycerides, over the normal limits, are attributed to after meal fat intake that increases its value.

Increased alkaline phosphatase is evident starting from the first month of study (from 621.30 ± 1.49 U / l at the first month to 722.30 ± 2.28 U / l in the 3rd month, p < 0.001). The decrease in alkaline phosphatase is clearly seen in the 3-4 months interval (269.10 ± 1.04 U/l,p<0.001). After the 4th month, alkaline phosphatase, present a slight increase which is maintained until the 8th mount (279.00 ± 1.10 U / L , p <0.001), at 12th month value drops to 278.80 ± 1.08 U / l , p< 0.001.

Influence of food with 30 % protein and 22 % fat is evident from month 1 (p<0.001). Alkaline phosphatase values are above maxim normal values throughout the 12 months period, but the administration of food with 30 % protein and 22 % fat results in a massive decline since the 3rd month. These high values of alkaline phosphatase can be based on bone isoensyme, since the animals were young. Increased alkaline phosphatase is also supported by hystopathological examination, changes were determined also by the liver damage (chart 6).
GGT increased from the 2nd month of administration (from 7.60 ± 0.80 U / l to 12.10 ± 0.87 U / l, p <0.001). From the 3rd month, GGT values begin to decrease until the 4th month (from 11.10 ± 0.54 U / l, p< 0.001 to 9.10 ± 0.86 U / l, p =0.140). From the 6th month, the GGT value increased (11.10 ± 0.83 U / l), being statistically significant (p <0.001). Between 6 to 12 months, the GGT records two statistically significant increases, one at the 6th month (11.10 ± 0.83 U / l, p<0.001) and the second at 12th month (11.70 ± 0.78 U / l, p<0.001). Between 2-12 months period, GGT values exceed physiological limits, food containing 30 % protein and 22 % fat produce significant changes within 2-3 months and 6-12 months after the start of administration.

Urea value increased since the 4th month (from 27.20 ± 0.87 mg / dl to 47.10 ± 1.30 mg / dl, p <0.001) after this month there is a downward trend that maintains also in the 12th month (from 47.10 ± 1.30 mg / dl in 4th month to 43.70 ± 0.90 mg / dl at 12th month, p <0.001). Urea value in the 6-12 months interval is statistically irrelevant relative to the values obtained at 4th months (p =1). Urea values are exceeding the maximum limits beginning at 4th month, remaining high throughout the administration of food with 30 % protein and 22 % fat (chart 7).
GOT values increase from the first month of food administration, statistically significant increase is maintained until 2nd month (from 69.10 ± 1.04 at U/l to 85.70 ± 1.42 U/l, p<0.001), followed by a decrease of GOT values in the 6th month (from 85.70 ± 1.42 U/l to 68.00 ± 0.77 U/l, p<0.001). The administration of food with 30 % protein and 22 % fat influences the value of the GOT in 1-5 month’s interval. In the 6th months p = 0.68, with no statistical significance.

GPT values increase during the first two months (from 71.80 ± 0.87U/l to 76.20 ± 0.75 U/l, p<0.001). In the 3rd month, GPT value decrease, which is maintained until 4th month (from 72.90 ± 0.83 U/l to 71.40 ± 0.92 U/l, p=0.014). Since 6th month GPT value present insignificant decrease until 12th month (from 73.80 ± 0.75 U/l, p=0.242 in 6th month to 72.80 ± 0.6 U/l, p = 0.314 in the 12th month). GPT values exceed normal limits throughout the period of 12 months, showing statistical significance at 2nd month and 4th month after initiation of the diet with 30 % protein and 22 % fat.

ISE -Na values increase from the first month of diet, upward trend that is maintained throughout the period of 12 months (from 135.40 ± 1.02mEq/l to 158.80 ± 0.75 mEq/l, p<0.001). ISE -Na values exceed the maximum limit of the physiological range between 4-12 months after the start of administration of food with 30 % protein and 22 % fat (Chart 8).

Elevated triglycerides, GGT, urea and GPT during the administration of food with 30 % protein and 22 % fat, associated with cholesterol increasing trend suggests a high caloric intake and possibly an increased amount of crude fibres in the diet. High values could be based on a slightly reactive biliary channels and probably transient cholestasis. Cell destruction caused increases in GGT, GOT and GPT, which are influenced by the patient’s anemic background.
Change in urea value, although not significant may be due to protein metabolism, and mild anemia.

ISE-Na values are most likely influenced by the state of dehydration of the animals. Low liquid consumption correlated with protein rich food leads to a state of mild dehydration which in turn causes a pseudo-rising in ISE-Na values.

In group III, hematological examination reveals a slight decrease in the number of red blood cells (from 5.23 ± 0.42 mil/mm³ to 5.08 ± 0.57 mil/mm³), hemoglobin (from 11.89 ± 0.35 g / dl to 10.41 ± 0.79 g / dl), MCV (from 58.20 ± 1.27 μ³ to 57.99 ± 1.0 μ³), haematocrit (from 33.09 ± 1.13 % to 32.01 ± 1.15%) and an increase in lymphocytes and MCHC, registering slight neutropenia, lymphocytosis and anemia. These values can be placed on low fluid consumption and occult gastrointestinal parasitism.

**Comparative statistical evaluation of biochemical values in the three studied groups**

ANOVA test for the evaluation of triglycerides is strongly significant and post hoc Tukey test also shows high significance (p<0.001). Therefore, administration of high protein and fat food increases triglycerides level. Greatest influence on triglyceride management presents food with 30% protein and 22 % fat.

ANOVA test is highly significant for comparing alkaline phosphatase values between the three groups and post-hoc Games-Howell test is also significant (p<0.001). Greatest
influence on alkaline phosphatase is observed when administering food with 18% protein and 8% fat (Chart 9).

Chart 9. Tryglycerides, alkaline phosphate evolution and standard evaluation, for 12 month period.

Major changes were noted in group II and group III compared with group I. Alkaline phosphatase shows a downward trend in all three groups. These values can also be made on account of bone maturation.

GGT values in group III are approximately equal to the values obtained in group I, except during 2, 6 and 12 month when they are smaller than the values obtained for group II. The administration of food with 30% protein and 22% fat in group III causes a similar trend of GGT to those found in group I and II.

Major modifications in GOT values are recorded in the administration of food with 30% protein and 22% fat. The administration of mixed food and food with 18% protein and 8% fat produce no significant changes in the values of GOT (chart 10).

CHART 10. GGT, GOT, evolution and standard deviation, for 12 month period in all groups
The major changes in the values of GPT are recorded in administration of food with 30% protein and 22% fat, followed by changes caused by the administration of food with 18% protein and 8% fat. Administration of mixed food lowers GPT values after the 3rd month.

In group III are elevated GPT and GOT values suggesting an increase in cellular damage and cholestasis as compared to group I and II.

Major modifications of urea are produce by administration of food with protein 18% and 8% fat, followed by the changes caused by the administration of food with 30% protein and 22% fat. Administration of mixed food does not cause significant changes in urea. Urea values are elevated in group II compared to group I and III, this being placed on protein metabolism and the anemic patient status.

Major modifications in ISE-Na values are recorded in the administration of food with 30% protein and 22% fat. The administration of mixed food and food with 18% protein and 8% fat causes no major changes on the values of ISE-Na (chart 11).

Biochemical changes that occur are underlined by subclinical internal parasitism, the time of sampling, and frequency of administration of food in dogs.

Chart 11. GPT, ure and ISE-Na evolution and standard deviation, for 12 month period in all groups
General conclusions

 Based on the results of statistical analysis and interpretation of data on the influence of dry food on some biochemical and hematological parameters in dogs several conclusions can be drawn.

 Changing the values of biochemical constituents was directly influenced by the type of food given and physiological status of dogs subjected to study.

 Alkaline phosphatase values exceed physiological limits throughout the period of the experiment in all groups studied. These values are determined by a slightly elevated hepatic cholestasis and bone isoenzyme, which has a physiologically increased activity in young animals in which the normal value of this isoenzyme is 4-9 times greater than the reference value in adults.

 Administration of dry food containing 18 % protein and 8 % fat and dry food containing 30% protein and 22 % fat results in a decrease in alkaline phosphatase beginning 3rd month, decrease value is maintained until 12th month, aspect assigned by us on the basis of bone maturation.

 Elevated values of triglycerides, GGT, urea and GPT encountered in group II and III of study who were fed dry food containing 18 % protein and 8 % fat and 30 % protein and 22 % fat associated with cholesterol increasing trend suggests a high caloric intake and an increased amount of crude fiber in the diet. These values indicate increased reactivity of the biliary channels and cholestasis associated with transient mild fatty infiltration of the liver parenchyma.

 Increased values of hepatobiliary enzymes, GGT and GPT, with a few units above the upper physiological limit indicates an increased release from cellular cytosol into the bloodstream following the cell damage or inflammation of the digestive tract. Half-life averaged of GPT's is 2.5 days, thus increasing in its value can be identified after the primary cause ceases.

 Elevated values of transaminases, GOT and GPT, enzymes that are found mostly in the liver, in direct correlation with alkaline phosphatase elevation in groups that received dry food with a high content of protein and fat indicate that the liver may have fatty infiltration state, cholestasis or cholecystitis.

 The slight increase in GOT values was not found in all the dogs subjected to the experiment, this is attributed to the short half-life of only 22 hours of the enzyme. Stronger growth in GPT's values can be attributed to its increased presence at the cellular level, liver
disease causes a massive release into the bloodstream and also the increase is potentiated by unknown intestinal parasitism.

Hematological examination in groups under study show a slight decrease in red blood cell count, hemoglobin, hematocrit, MCV’s and an increase in lymphocytes and MCHC, which causes a slight neutropenia, lymphocytosis and mild anemia. Changes of these values cannot be directly correlated with the contents of food received, but rather the low consumption of fluids.