

Evaluation of **VACUETTE**[®] CAT Serum Fast Separator Blood Collection Tube for Routine Chemistry Analytes in Comparison to **VACUTAINER**[®] RST Tube

Background:

Greiner-Bio-One, Austria has been selling plastic evacuated tubes (**VACUETTE**[®]) for venous blood collection since 1986.

VACUETTE[®] CAT Serum Fast Separator blood collection tubes contain thrombin in addition to the blood clotting activator to further accelerate the clotting process.

Due to the rapid clotting process within 5 minutes after blood collection and the following centrifugation, the **VACUETTE**[®] CAT Serum Fast Separator blood collection tubes enable faster turnaround times similar to plasma tubes. The tubes are suitable for the usage on routine chemistry analyses for patients who are not on any heparin or other thrombin inhibitor therapy.

The **VACUETTE**[®] CAT Serum Fast tube is offered as a gel separator tube. The gel has a specific gravity, forms a stable barrier between the blood cells and the serum during centrifugation and provides stability for most analytes up to 48h when measured out of the primary tube stored at 4-8°C.

Study Objective:

The study has been carried out to demonstrate that **VACUETTE**[®] CAT Serum Fast Separator blood collection tubes are suitable for routine chemistry analysis for up to 48h after centrifugation in comparison to **VACUTAINER**[®] RST Blood Collection tubes when centrifuged at 1800g for 10 min as well as at 3000g for 5 min.

Study design and procedure:

Venous whole blood was collected from 20 healthy donors aged 18-64 years by using a **VACUETTE**[®] SAFETY Blood Collection Set (Item #450085) and a **VACUETTE**[®] No Additive tube as discard tube, into the following tubes:

Sample	Tube description	Prod. No.	Volume [ml]	Centrifugation
A	VACUTAINER [®] RST tube	368774	5	1800g for 10 min
B	VACUETTE [®] CAT Serum Fast Separator tube	456310	5	1800g for 10 min
C	VACUTAINER [®] RST tube	368774	5	3000g for 5 min
D	VACUETTE [®] CAT Serum Fast Separator tube	456310	5	3000g for 5 min

One tube of each sample was drawn from each donor. All samples were gently inverted 6 times. Exactly after 5 min clotting time (stopwatch was started after last inversion), all samples were centrifuged according to the centrifugation setting in the table above at 22°C (centrifuge: Hettich Rotanta 460R for Sample A and B; Hettich Rotanta 420R for Sample C and D). After centrifugation, all samples were visually inspected if there were any floating clots in the serum. Initial analysis was done after centrifugation on an AU680 and DxI800 from Beckman Coulter. All samples were stored in an upright position at 4-8°C before being analyzed again after 48h.

Analytes on Beckman Coulter AU680 and Dxl800:

Parameter	Abbreviation	Acceptance criteria Rilibäk (CLIA, NYS)
Alanine Transaminase	ALT	11.50%
Albumin	ALB	12.50%
Alkaline Phosphatase	ALP	11%
Amylase	AMYL	30% ^{2,3}
Aspartate Transaminase	AST	11.50%
Calcium	Ca	6%
Chloride	Cl	4.5%
Cholesterol	CHOL	7%
C-reactive Protein	CRP	13.50%
Creatine Kinase	CK	11%
Creatinine	Crea	11.50%
Cytomegalovirus IgG	CMV	no false positive / false negative
Ferritin	FER	13.50%
Folic Acid	FOL	30% ³
Free Triiodothyronine	fT ₃	13%
Gamma Glutamyltransferase	GGT	11.5%
Glucose	Gluc	11%
High Density Lipoprotein	HDL	30% ^{2,3}
Inorganic Phosphate	IP	9%
Iron	Fe	20% ^{2,3}
Lactate-Dehydrogenase	LDH	20% ^{2,3}
Hemolytic index	LIH	n.a.
Lipase	LIP	30% (source CAP)
Magnesium	Mg	7.50%
Potassium	K	4.50%
Sodium	Na	3%
Thyroid-stimulating hormone	TSH	13.50%
Total Bilirubin	TBil	20% ^{2,3}
Total Protein	TP	6%
Triglyceride	TG	9%
Troponin I	Trop I	20%
Urea	Urea	10.5%
Uric Acid	UA	7%
Cobalamine (Vitamin B ₁₂)	VitB ₁₂	25% ³
Vitamin D ₃	Vit D	19,95% (RCV)

Comparison analysis was performed at all time points of determination. Statistics were performed using StatSoft Software, Version 13.2.

Clinical evaluation was based on the allowed recommendation by the German Medical Association (RILIBÄK) ^[6]. If no acceptance criteria is listed in Rilibäk, CLIA ^[7], NYS ^[8] or CAP ^[9] guidelines were used.

Results:

Measurement of LIH:

All samples of all donors were negative for lipemia, icterus and hemolysis, except for donor 6. All samples of donor 6 were icteric (2.5 – 4.9 mg/dl Bilirubin).

Initial measurement:

At initial measurement, equivalent performance between **VACUETTE**[®] CAT Serum Fast Sep and BD Vacutainer[®] RST Gel tubes tube has been confirmed.

Centrifugation at 1800g for 10 min

No clinically significant deviations have been found comparing sample B to A. Systematic deviation for potassium was found to be without clinical significance.

Centrifugation at 3000g for 5 min

Significant deviations have been found for Mg in 15% and for Vit D in 15% for all donors. Systematic deviation for potassium was found to be without clinical significance.

The deviations for Magnesium and Vitamin D between BD Vacutainer[®] RST Gel tubes and **VACUETTE**[®] CAT Serum Fast Sep are acceptable from a clinical perspective.

Measurement after 48 hours (storage at 4 – 8°C):

At 48h measurement, substantially equivalent performance between **VACUETTE**[®] CAT Serum Fast Separator and BD Vacutainer[®] RST tubes has been confirmed apart from Troponin.

Centrifugation at 1800g for 10 min

Significant deviations have been found for the comparison of BD Vacutainer[®] RST tubes and **VACUETTE**[®] BCA Fast Sep tubes for Tbil and Troponin.

Significant deviations have been found for Mg and for Tbil in both tubes over time.

Centrifugation at 3000g for 5 min

Significant deviations have been found for Mg and for Tbil in both tubes over time.

Bilirubin is light sensitive and is recommended to be determined out of an amber tube when the sample has to be stored. The deviation found for Magnesium in relation to the initial measurement is comparable to BD Vacutainer[®] RST tubes. Magnesium and Troponin are recommended to be determined as soon as possible after centrifugation.

Systematic deviations after storage of 48 hours were found for Ca, Cl, CRP, HDL, IP, K, LDH, TG, TP and Vit B12 without clinical significance. The deviations for Magnesium and Tbil are also systematic.

One visible clot was seen in sample 1B (at 1800g) and one clot was seen (at 3000g) in sample 14D. The clot of sample 1B led to an error message (clot alarm) on the instrument Beckman Coulter Dxl 800, the clot of sample 14D did not lead to an error message. None of these clots did lead to deviations for any parameter.

Conclusion:

The substantially equivalent clinical performance of the **VACUETTE**[®] CAT Serum Fast Separator Blood Collection Tube in comparison to the VACUTAINER[®] RST Blood Collection Tube has been demonstrated for routine biochemical analytes on a Beckman Coulter analyzer at initial time and after 48h (except troponin I) for healthy donors. Deviations found for Magnesium, Vitamin D, and Bilirubin are considered to be clinically acceptable.

Provided a clear serum after centrifugation, the utilization of the **VACUETTE**[®] CAT Serum Fast Separator tube enables a faster turnaround time in the laboratory due to the rapid clotting process minimizing the cell lysis ^[1/2] in the tube within 5 minutes due to the thrombin additive.

From the rapid clotting process, resulting systematic bias such as the electrolytes sodium, potassium, chloride or total protein in comparison to laboratory reference values as described in literature have to be considered.

References:

[1] W.-Y. Ng, C-P. Yeo, Thrombin-Accelerated Quick Clotting Serum Tubes: An Evaluation with 22 Common Biochemical Analytes. *Advances in Hematology* (2013),

[2] S.J.Steindel, Evaluation of a Thrombin Containing Blood Collection Tube. *Clin. Chem.*, Vol. 26, 1, (1980)

[3] M. Kojancic, J. Cargonja, A.Delic-Knezevic. Evaluation of the BD Vacutainer RST blood collection tube for routine chemistry analytes: clinical significances of differences and stability study *Biochemica Medica* 2014; 24: 368-75

[4] Huyghe T et al. Studies on the use of BD Vacutainer SSTII and RST in general practice: investigation of artefactual hyperkalemia. *Ann Clin Biochem* 2014; 51: 30-37

[5] Koch et al, BD rapid serum tubes reduce false positive plasma troponin T results on the Roche Cobas e411 analyzer. *Clin Biochem* 2012; 45: 842-44

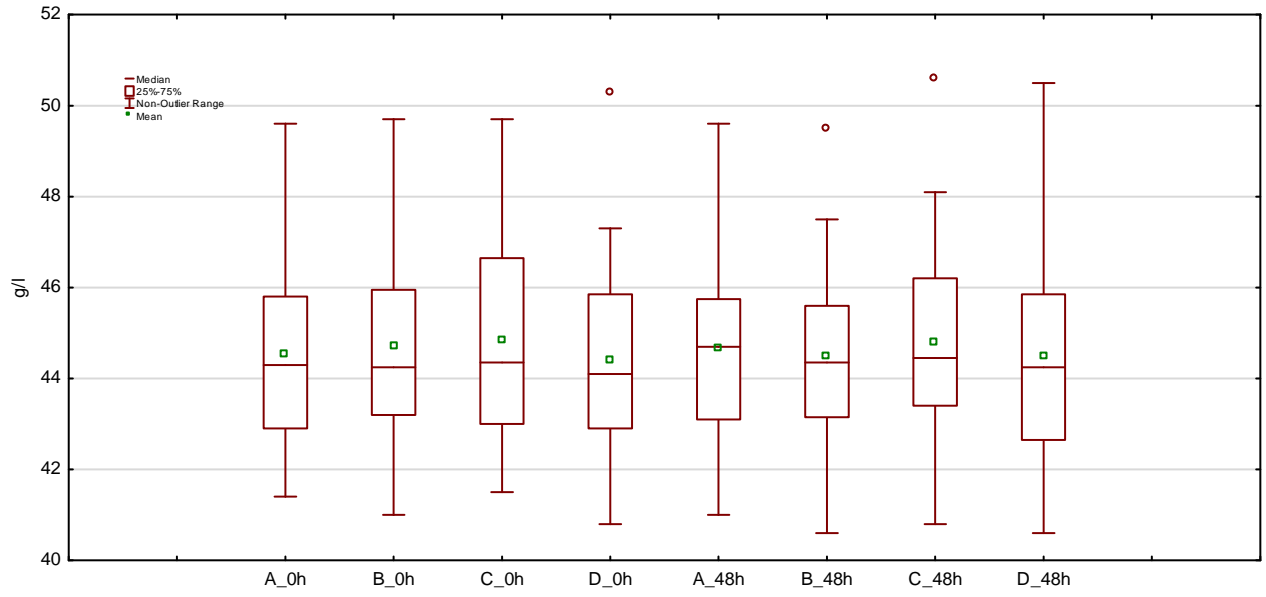
[6] Guideline from the medical association in Germany for quality assurance of laboratory tests. *German Medical Journal*. Vol 105, Issue 7, 2008

[7] Clinical Laboratory Improvement Amendments (CLIA)

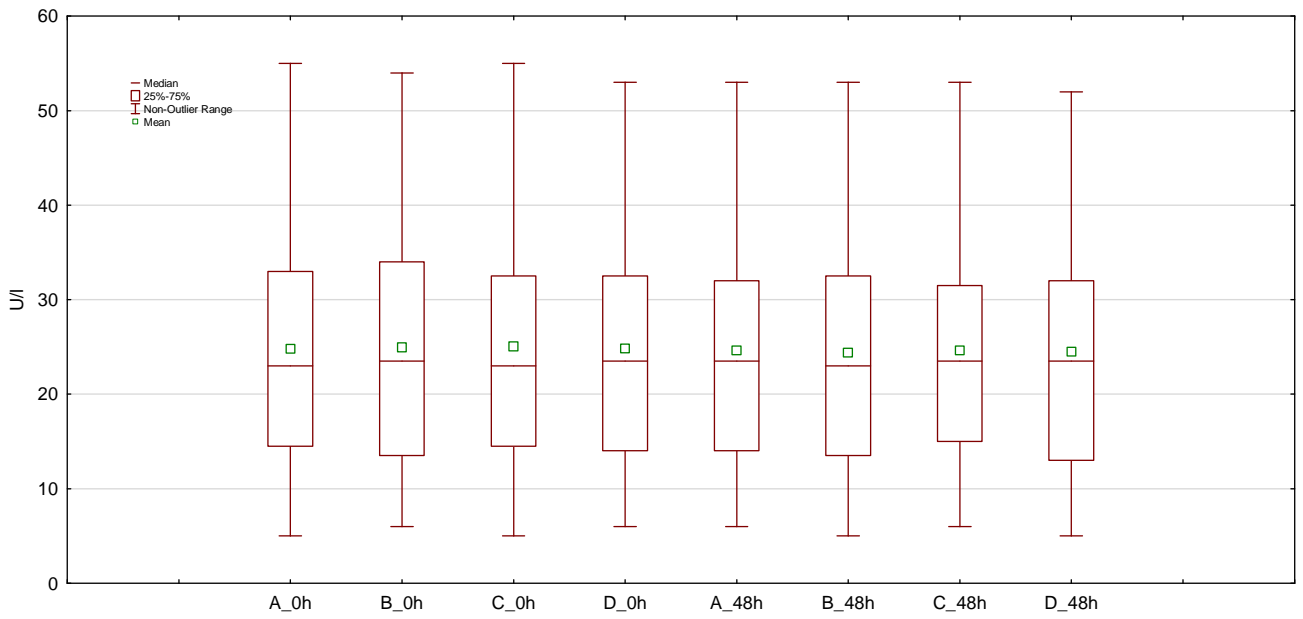
[8] Wadsworth Center of the New York State Department of Health (NYS)

[9] College of American Pathologists

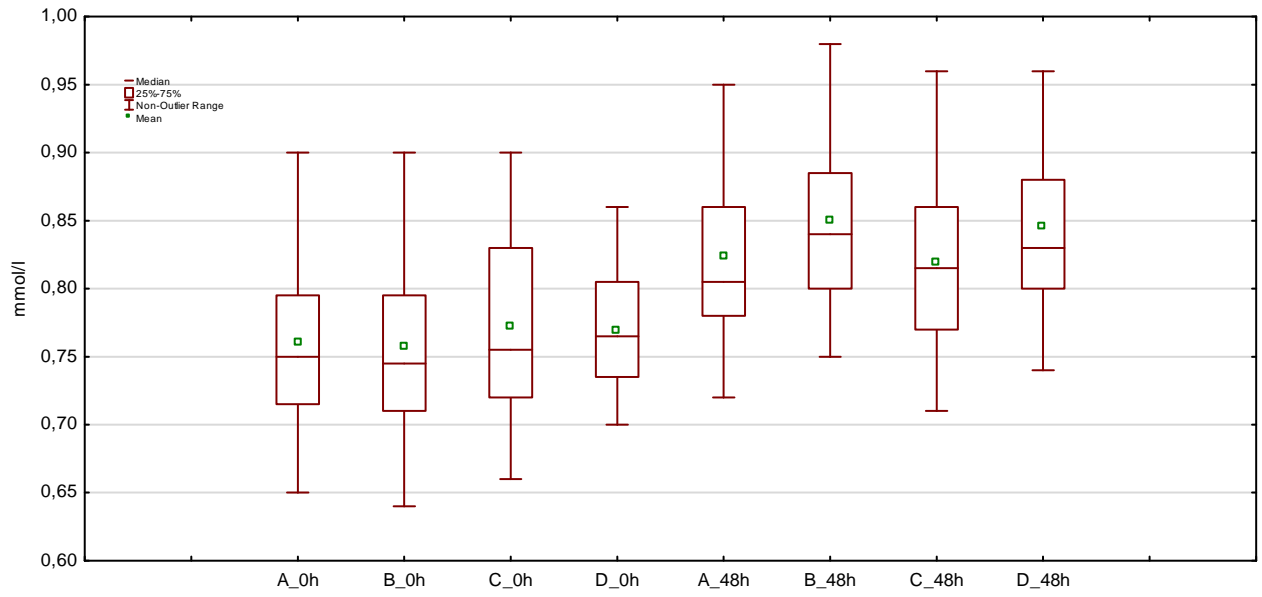
Albumin (Normal Range: 35 - 52 g/l)



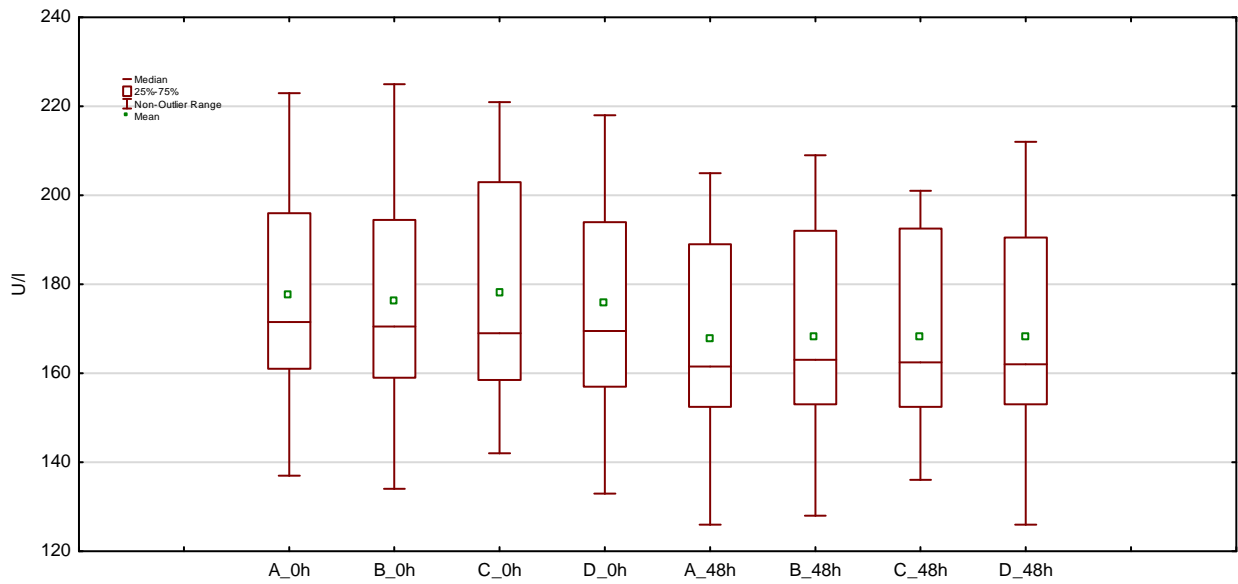
Lipase (Normal range: < 67 U/l)



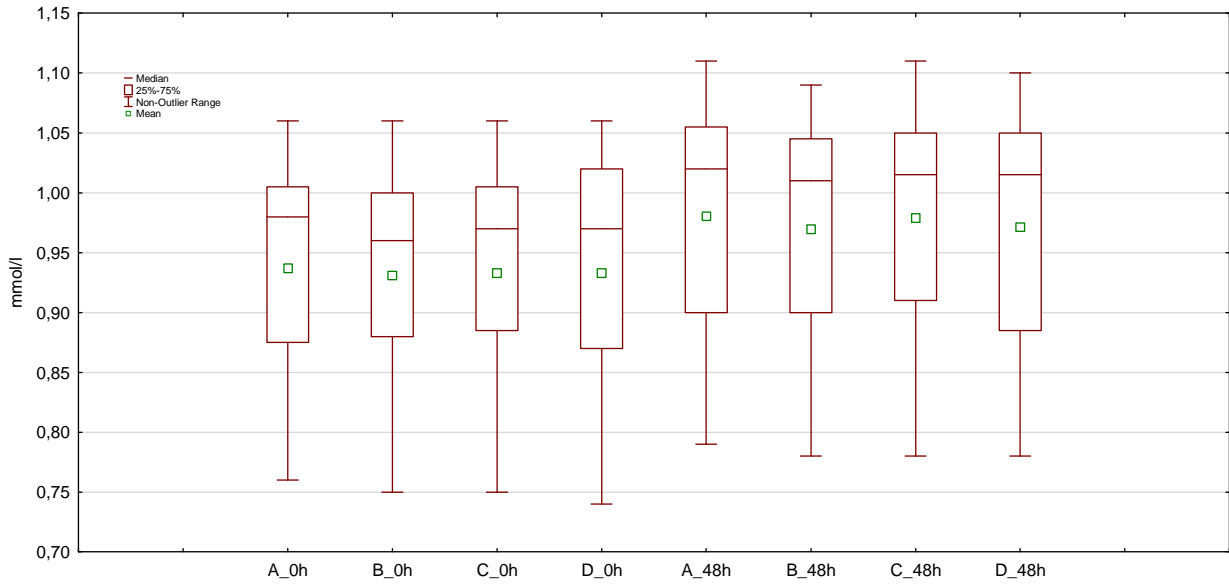
Magnesium (Normal range: (f) 0.73 - 1.06 mmol/l; (m) 0.77 - 1.03 mmol/l)



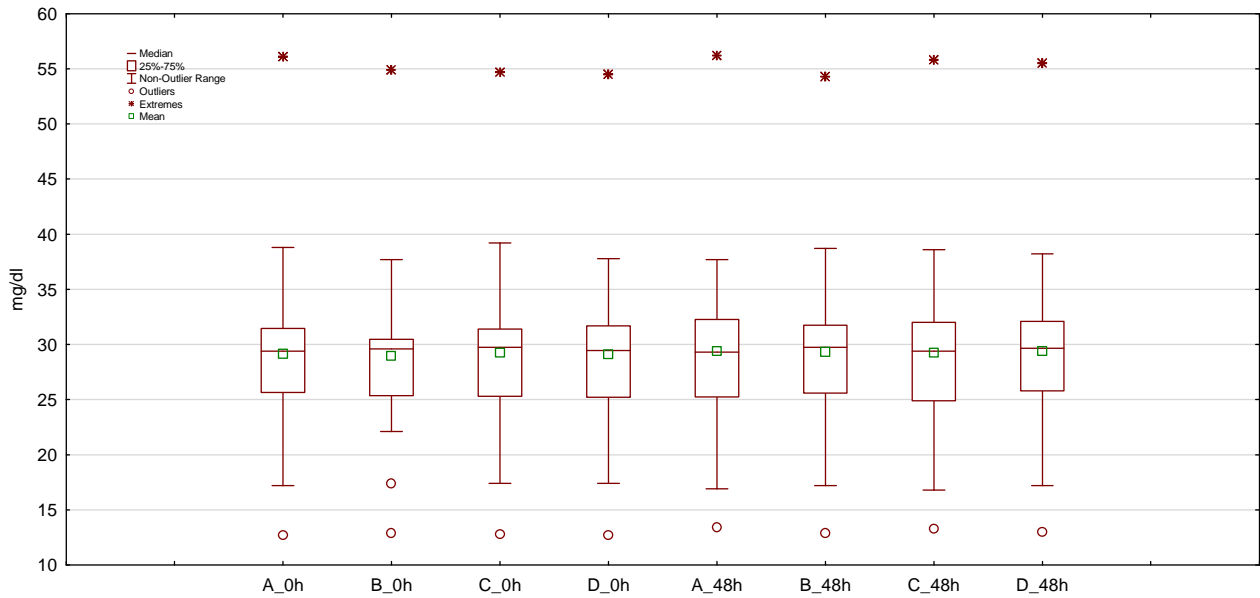
Lactate-Dehydrogenase (Normal range: (f) < 247 U/l; (m) < 248 U/l)



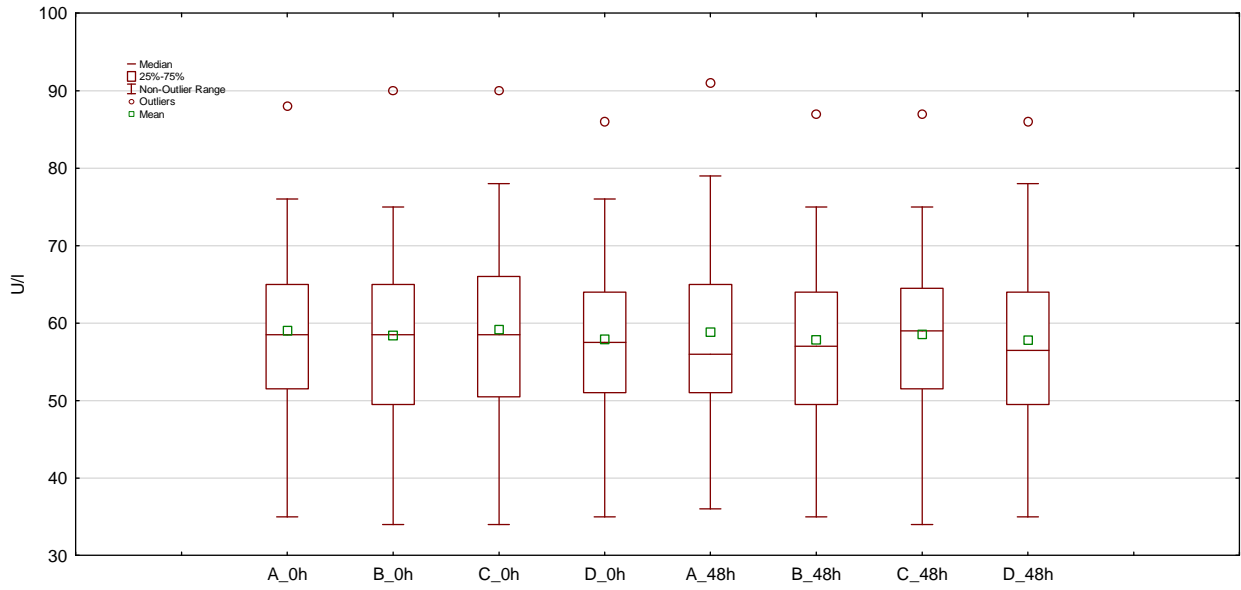
Phosphate inorganic (Normal range: 0.81 - 1.45 mmol/l)



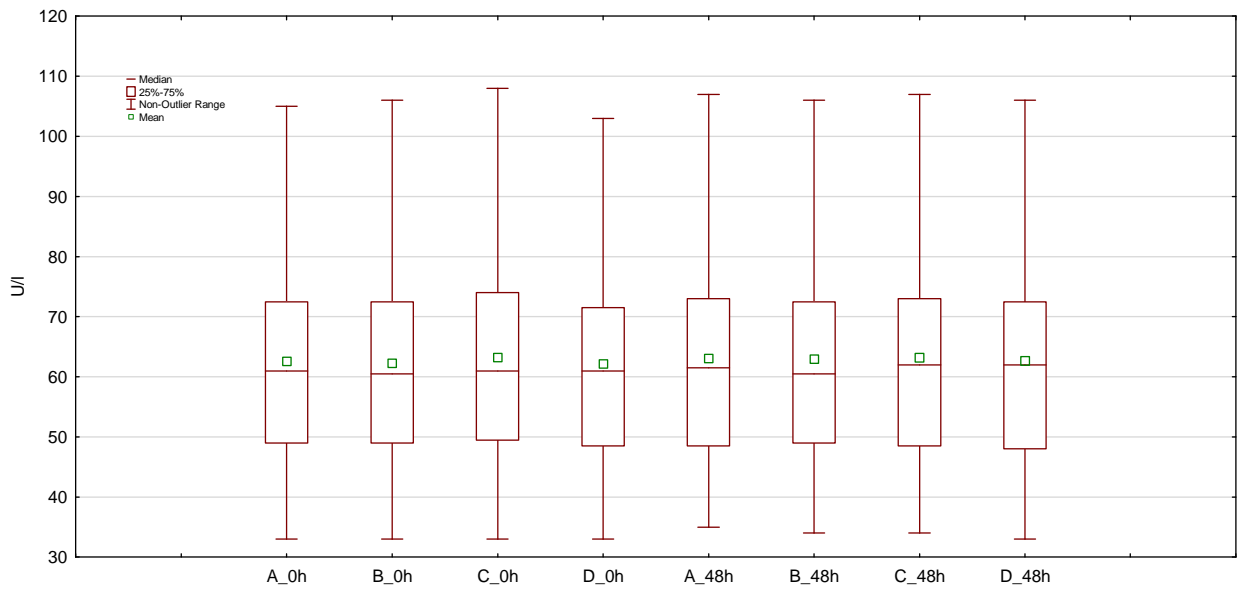
Urea (Normal range: 17 - 43 mg/dl)



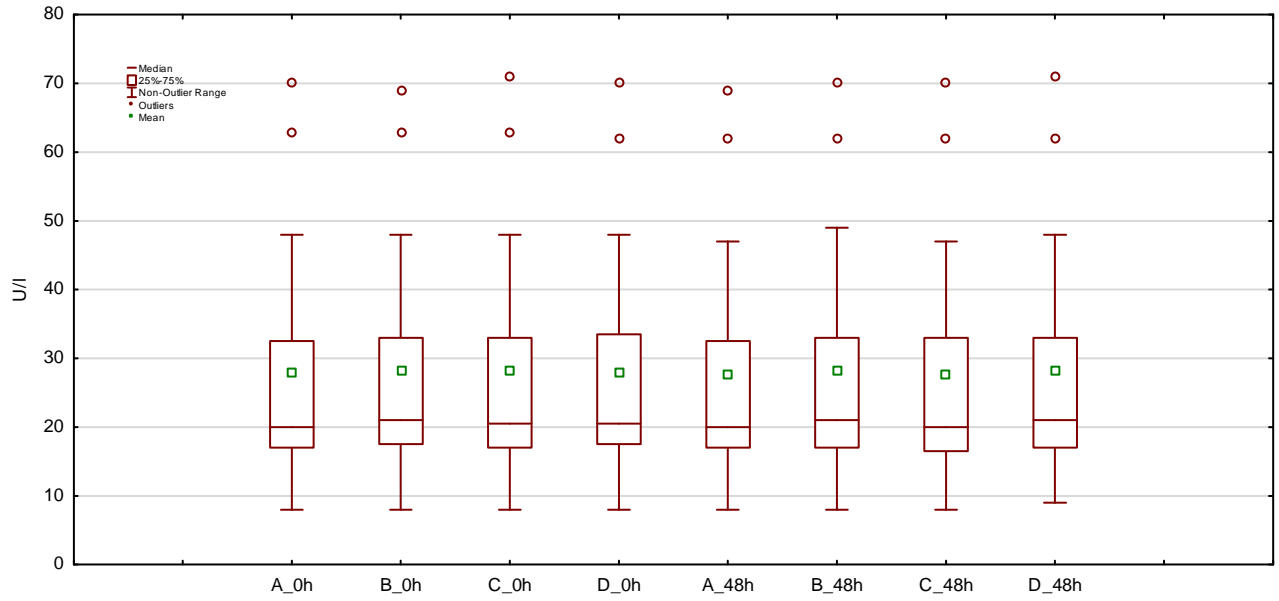
Alkaline phosphatase (Normal range: 60 - 200 U/l)



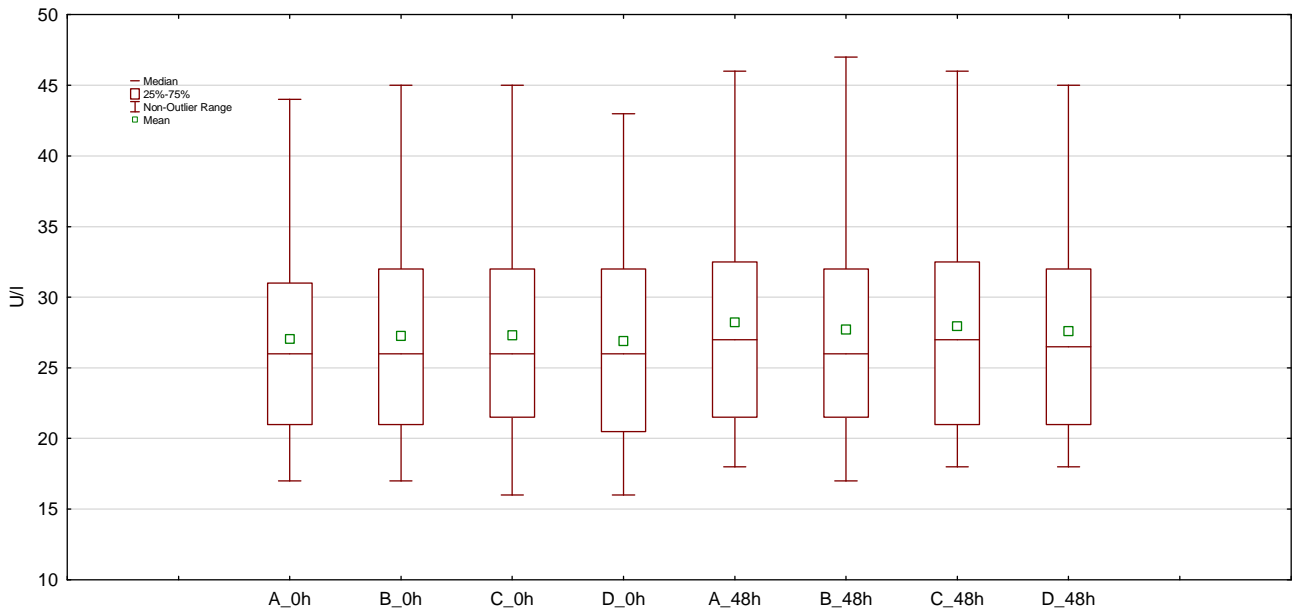
Amylase (Normal Range: 28 - 100 U/l)



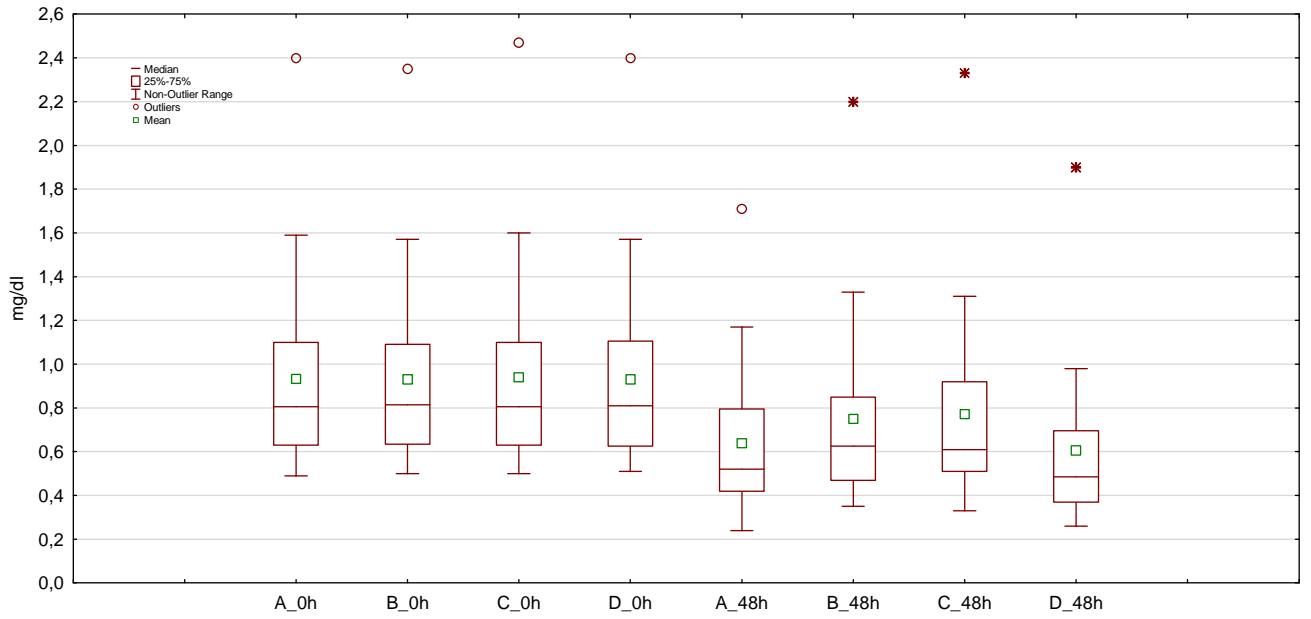
Alanine transaminase (Normal range: (m) < 50 U/l (f) < 35 U/l)



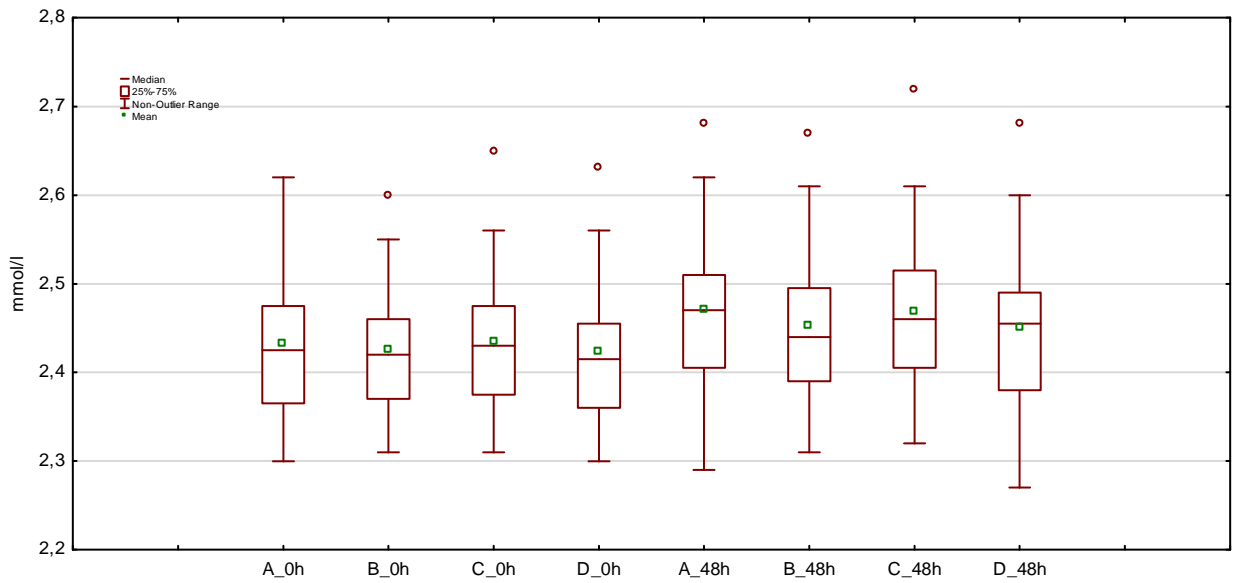
Aspartate transaminase (Normal range: (m) < 50 U/l (f) < 35 U/l)



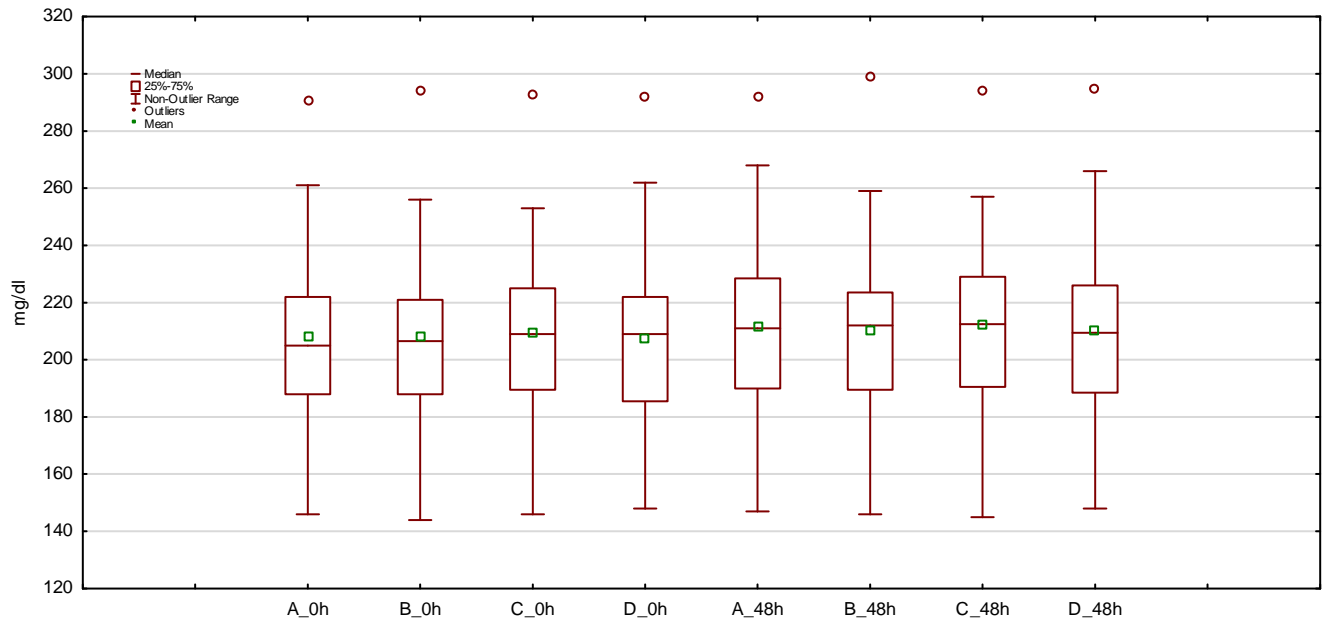
Total Bilirubin (Normal range: 0.3 - 1.2 mg/dl)



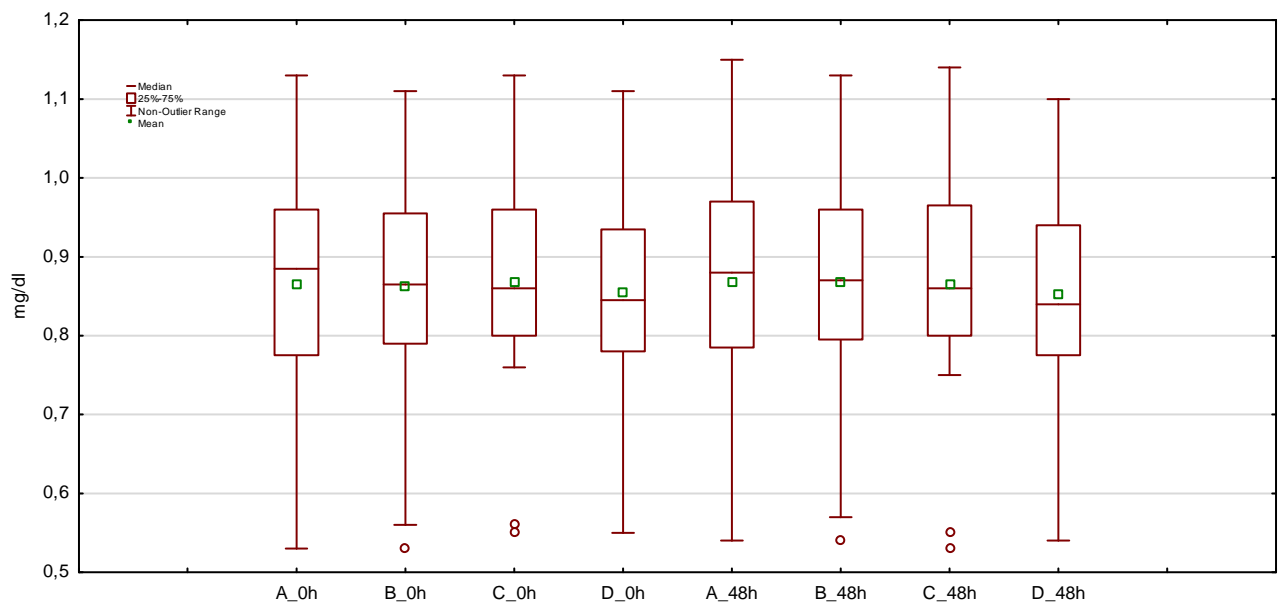
Calcium (total) (Normal range: 2.20 - 2.65 mmol/l)



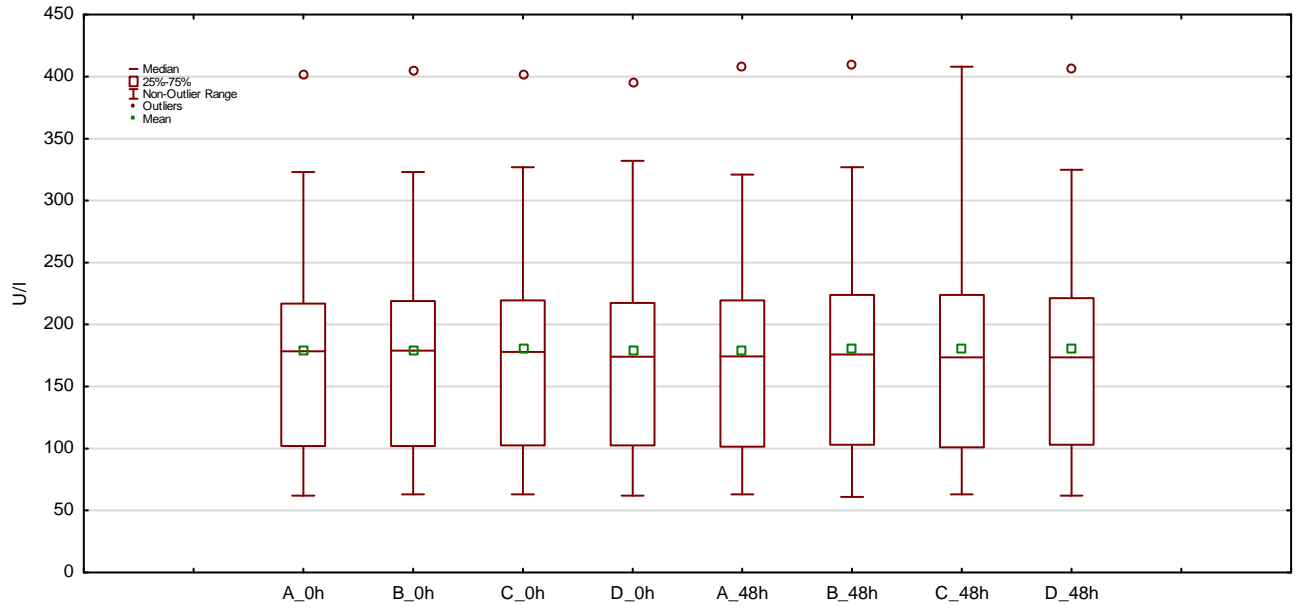
Cholesterol (Normal range: < 200 mg/dl)



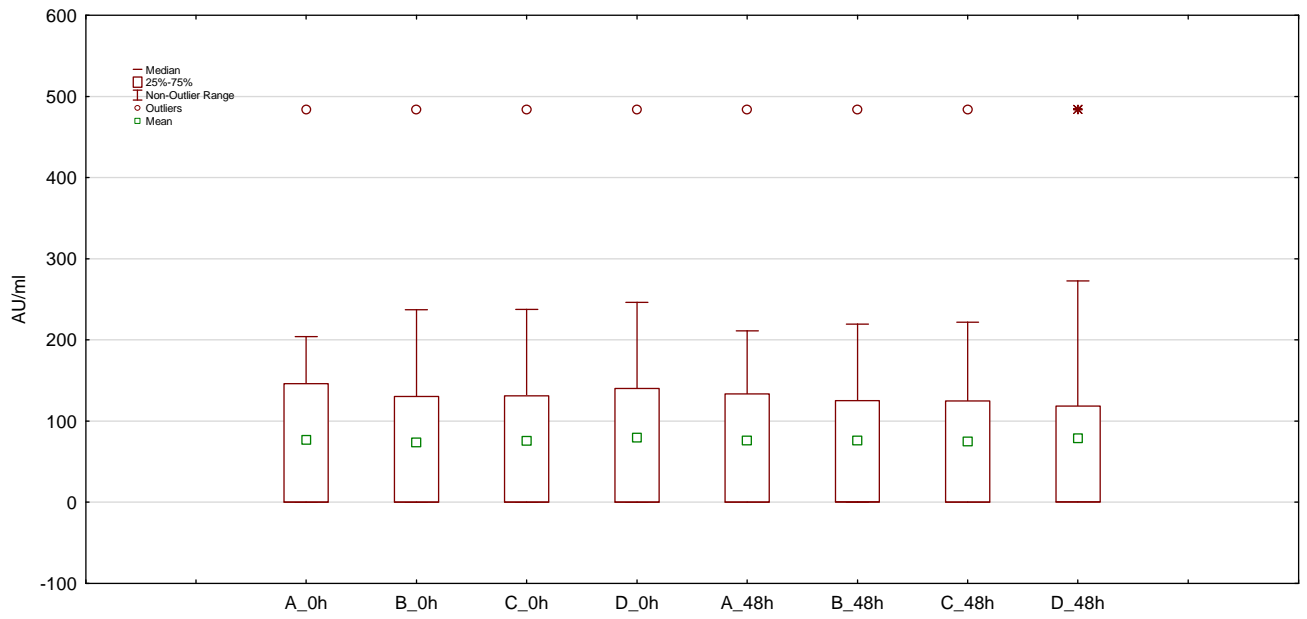
Creatinine (Normal range: (f) 0.72 - 1.18 mg/dl; (m) 0.55 - 1.02 mg/dl)



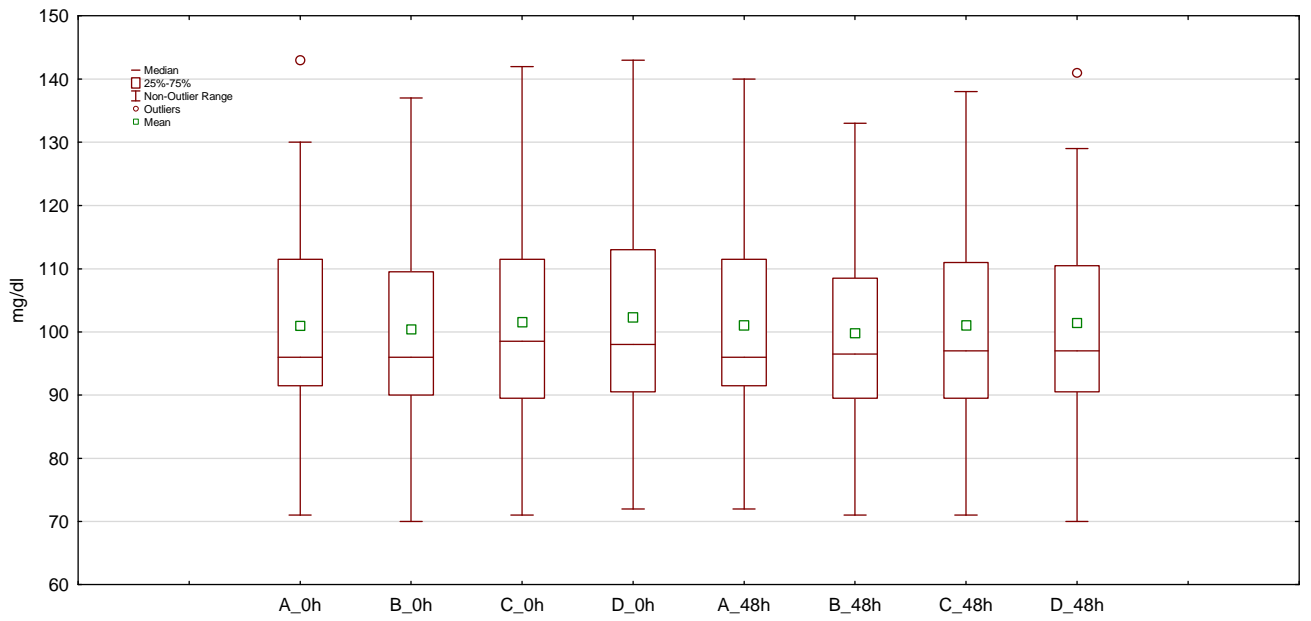
Creatine kinase (CK-NAC) (Normal Range: (m) ≤ 171 U/l; (f) ≤ 145 U/l)



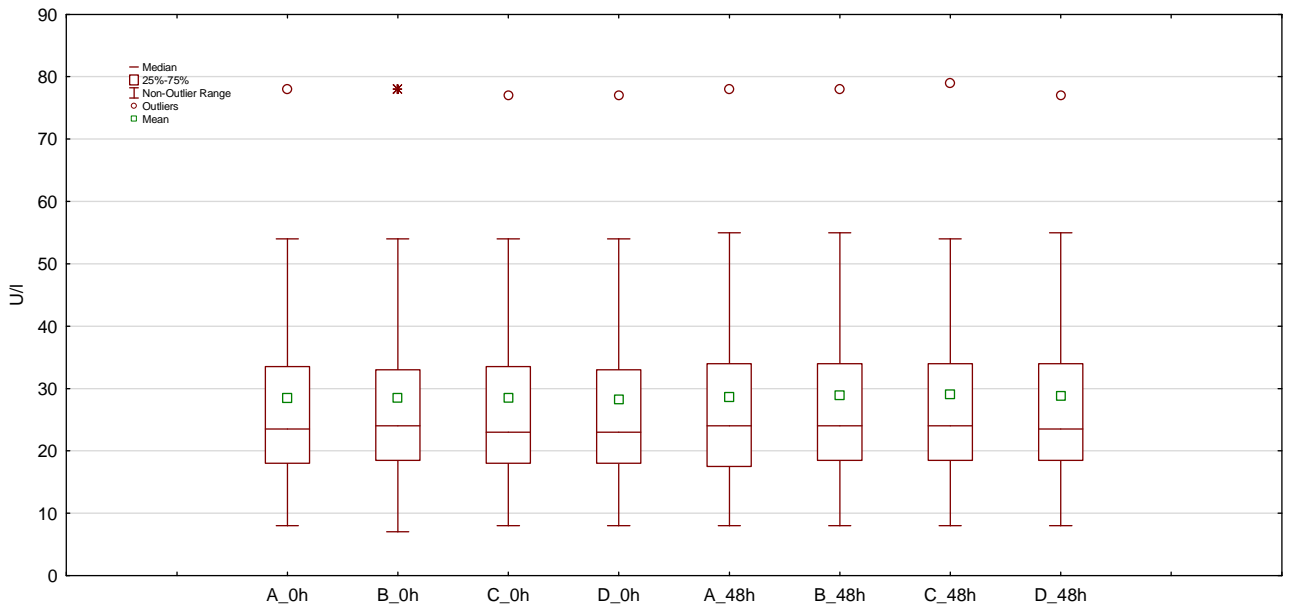
Cytomegalovirus IgG (Normal Range: non-reactive <11AU/ml, grey area ≥11AU/ml and <15AU/ml, reactive ≥15AU/ml)



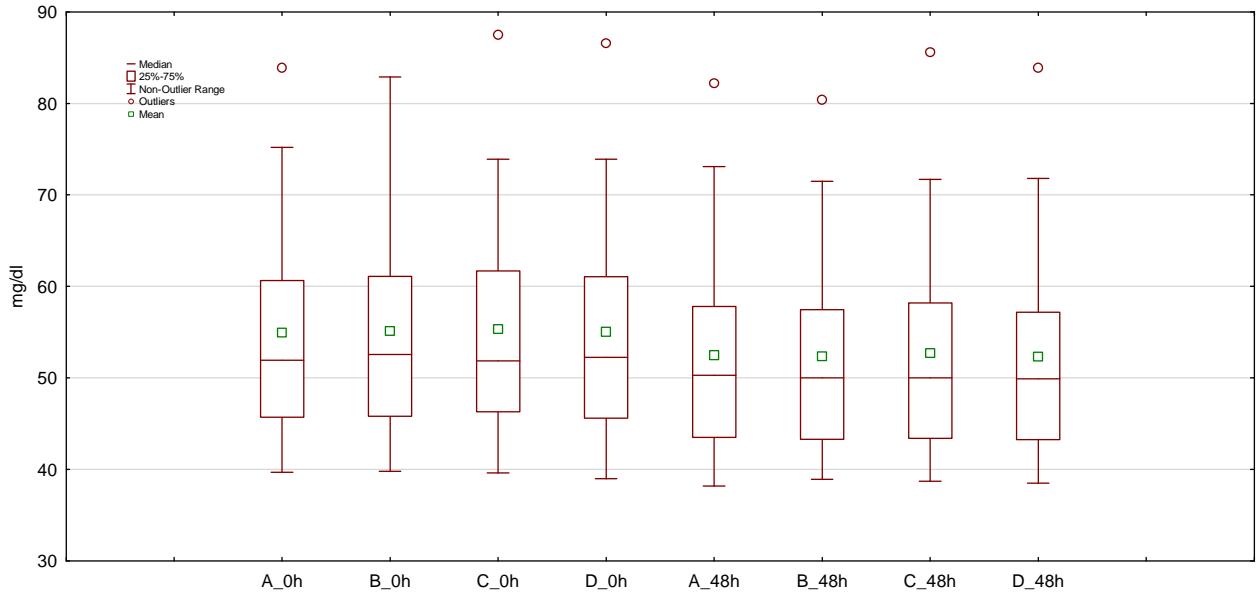
Glucose (Normal range: 74 - 106 mg/dl)



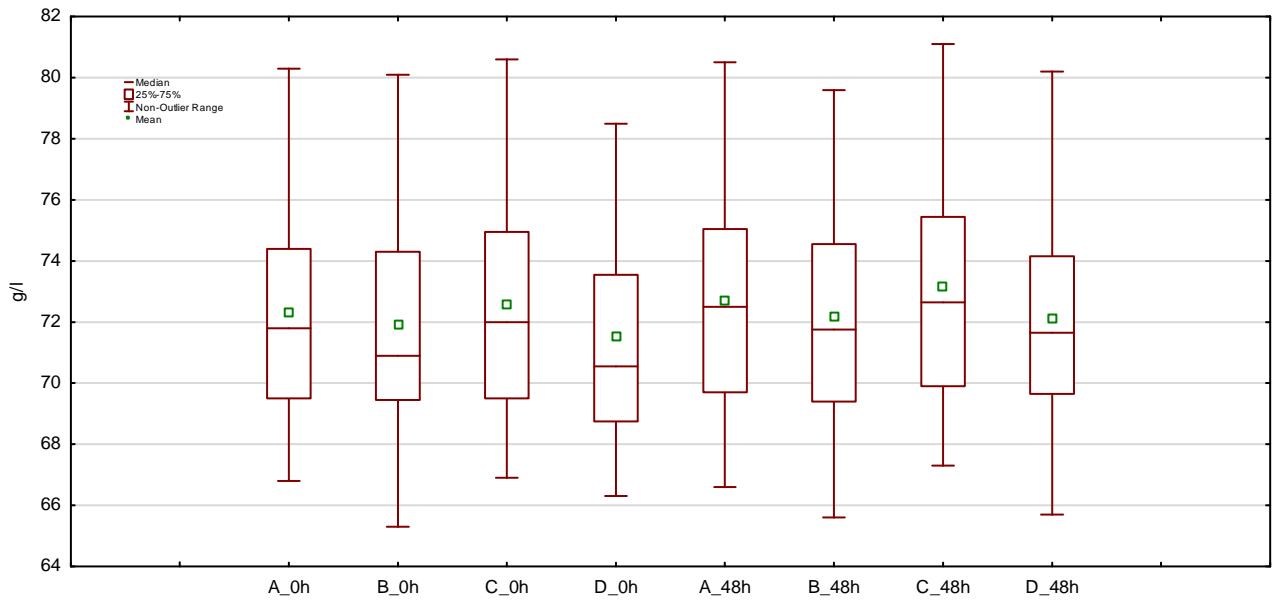
Gamma glutamyltransferase (GGT) (Normal Range: (m) < 55 U/l (f) < 38 U/l)



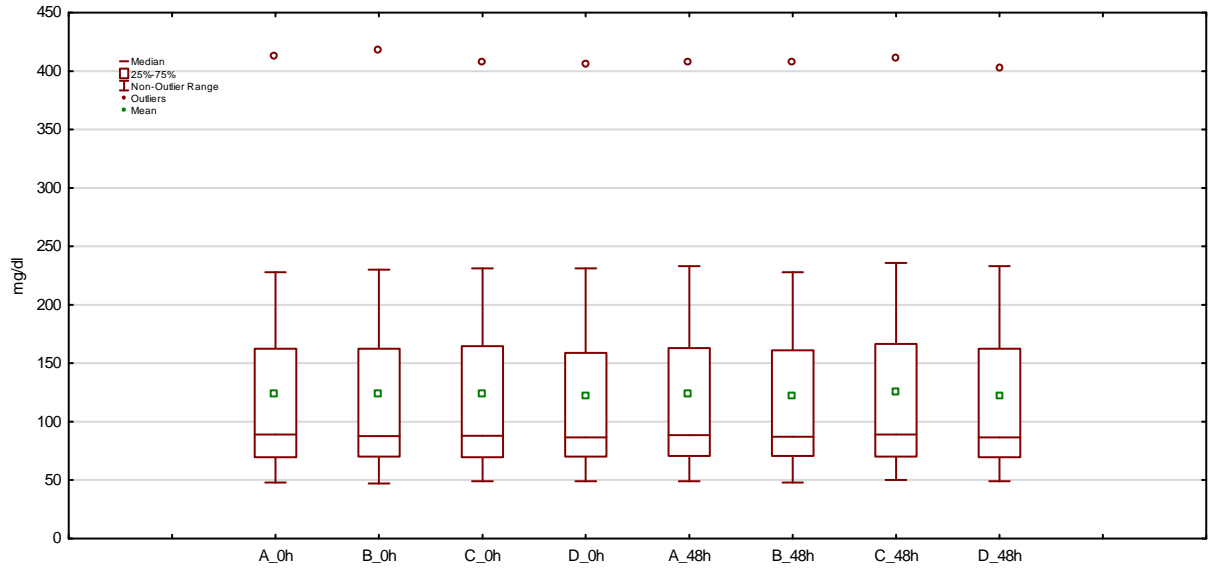
High Density Lipoprotein (Normal range: ≥ 40 mg/dl)



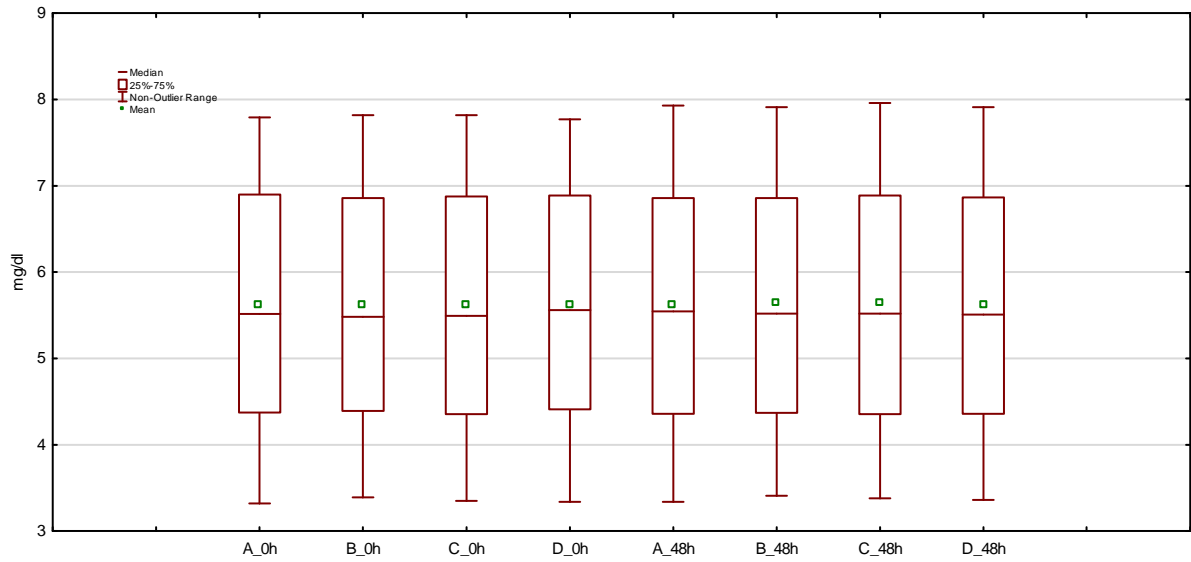
Total Protein (Normal range: 66 - 83 g/l)



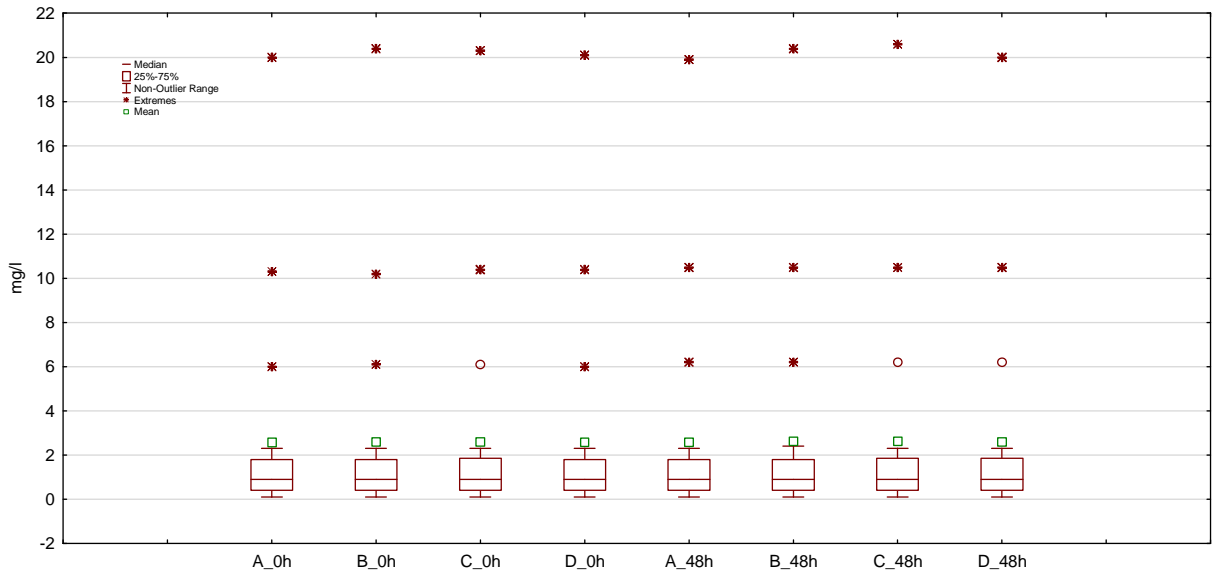
Triglyceride (Normal range: normal ≤ 150 < borderline high < 200 high < 500 very high)



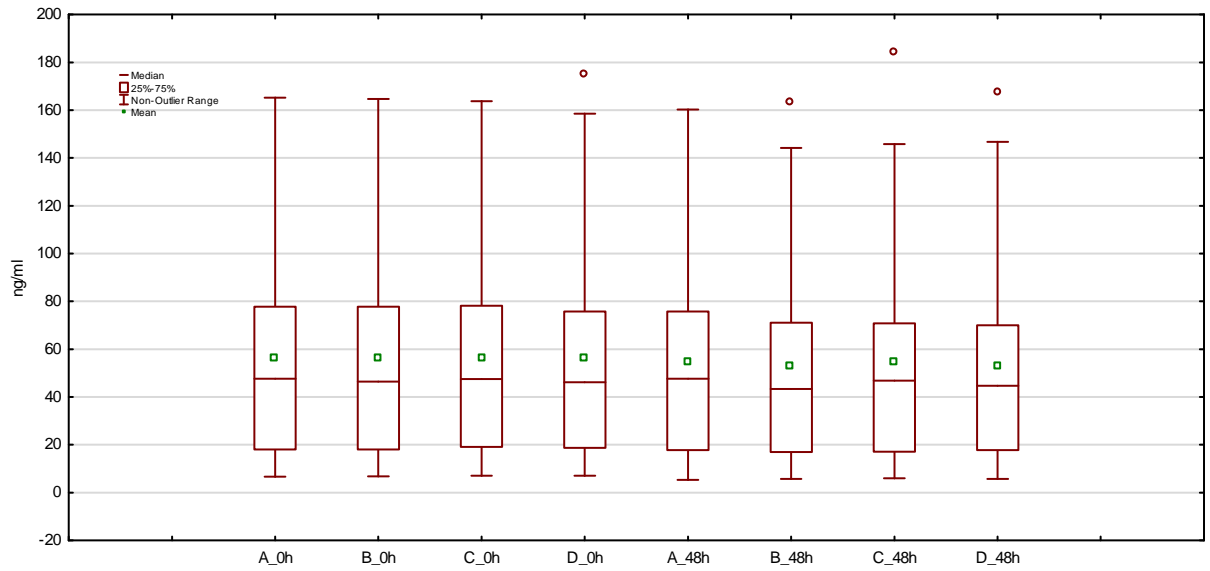
Uric acid (Normal range: (f) 3.5 - 7.2 mg/dl, (m) 2.6 - 6.0 mg/dl)



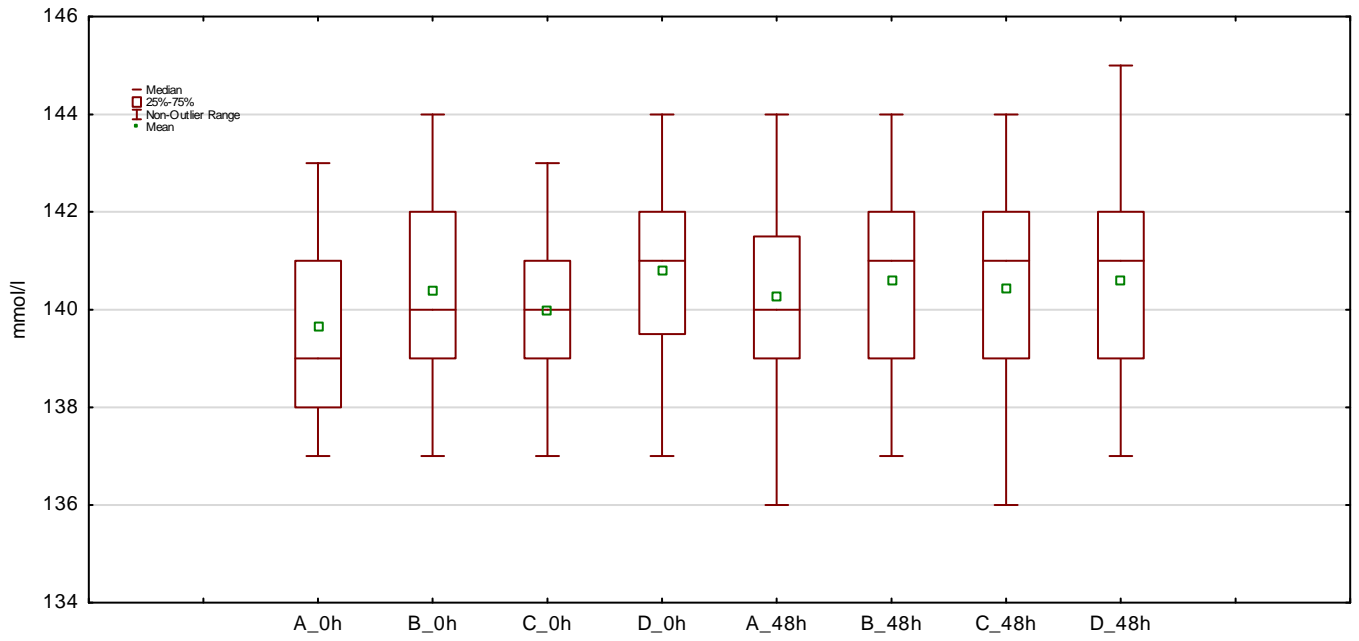
C-reactive protein (Normal range: <5 mg/l)



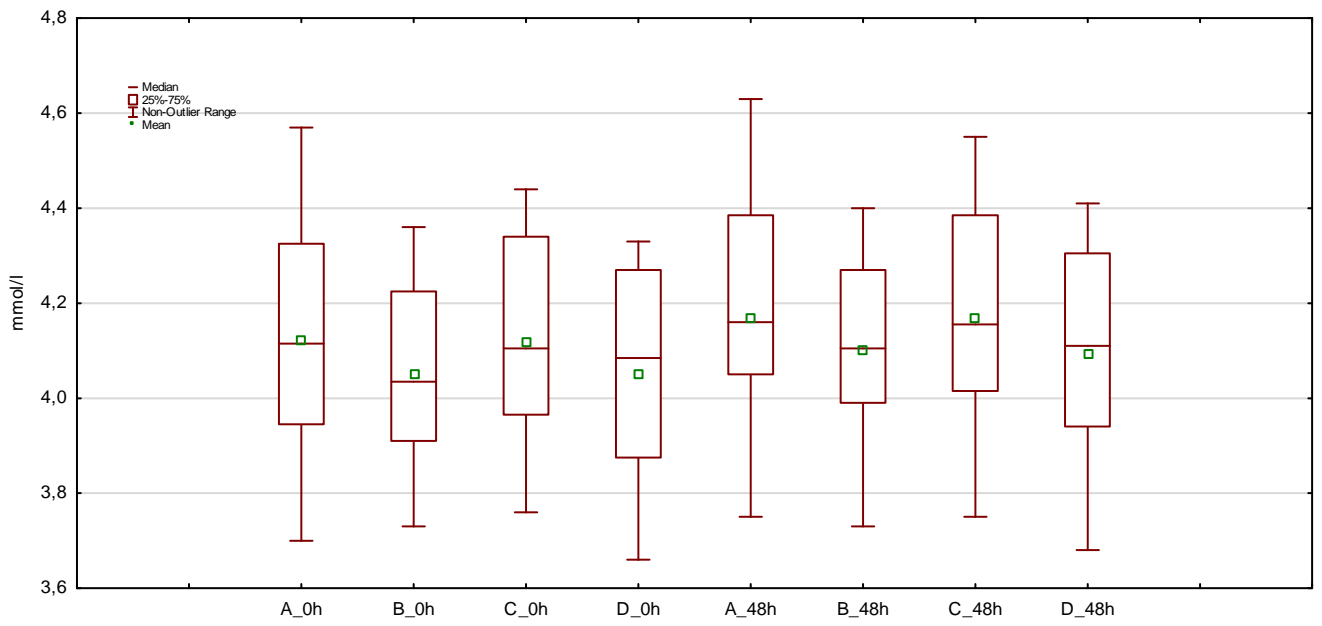
Ferritin (Normal range: (f) 20 - 250 µg/l;(m) 10 - 120 µg/l)



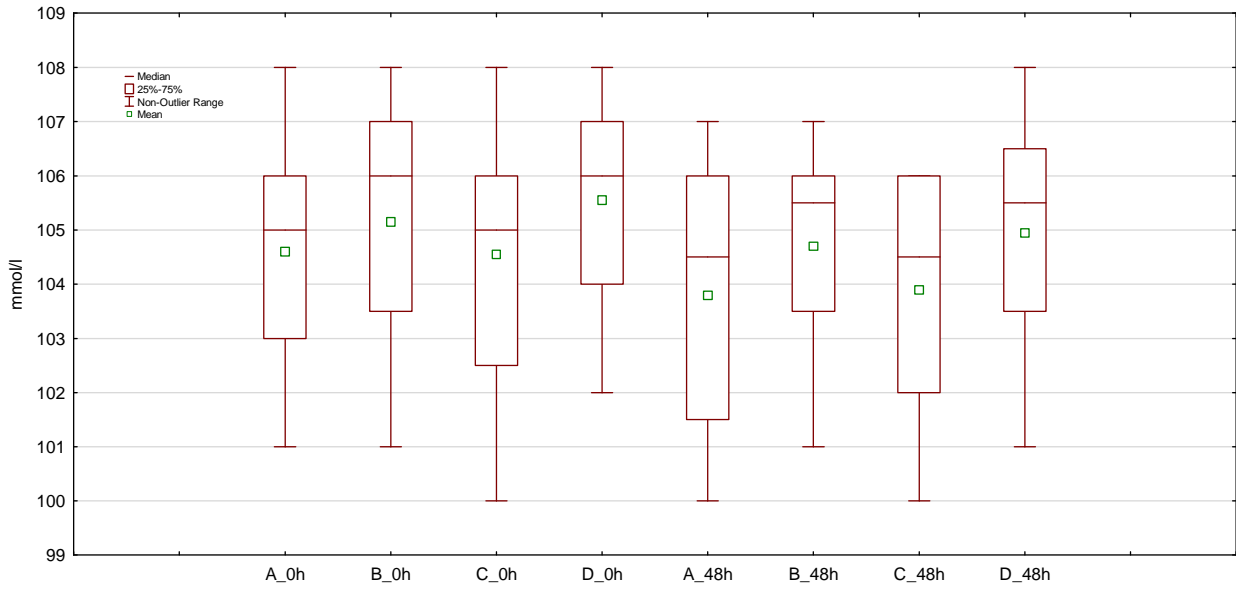
Sodium (Normal range: 136 - 146 mmol/l)



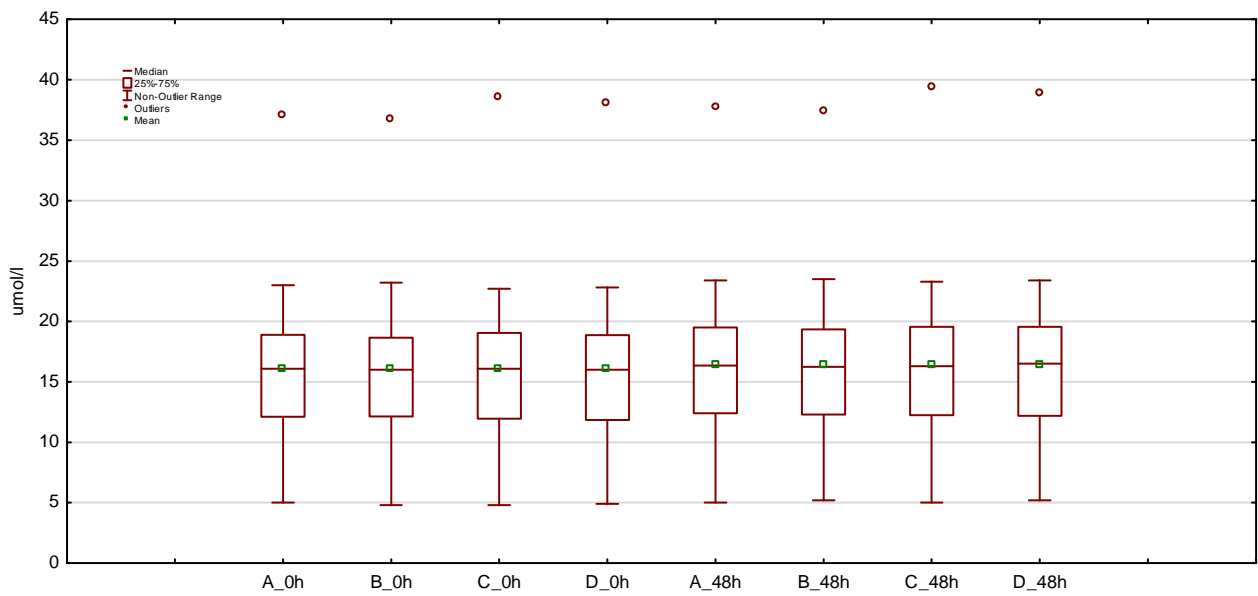
Potassium (Normal range: Serum 3.5 - 5.1 Plasma 3.4 - 4.5 mmol/l)



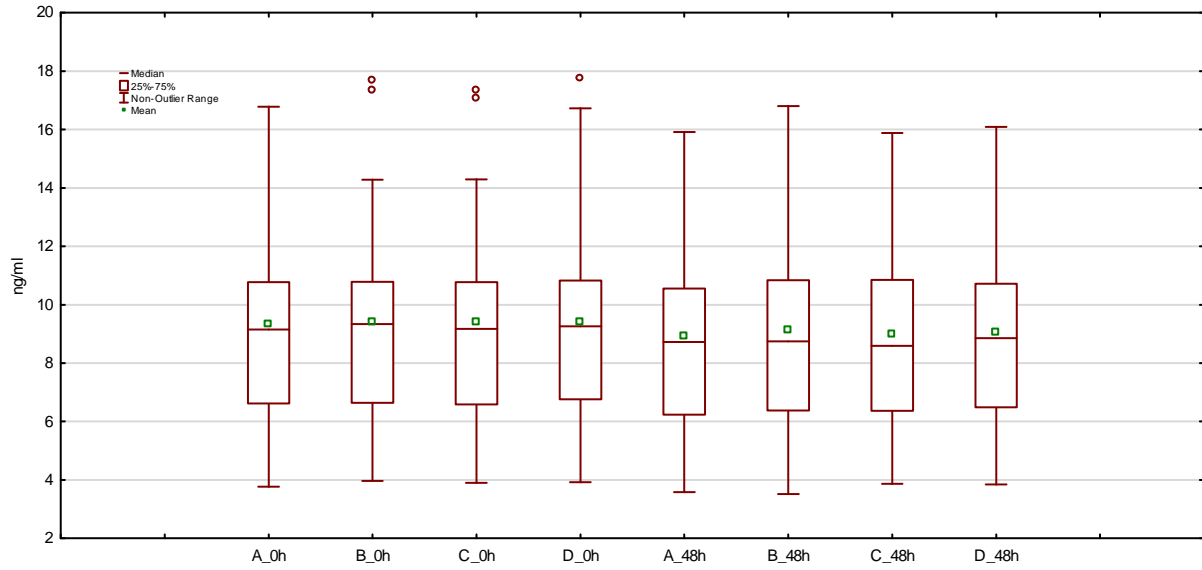
Chloride (Normal range: 101 - 109 mmol/l)



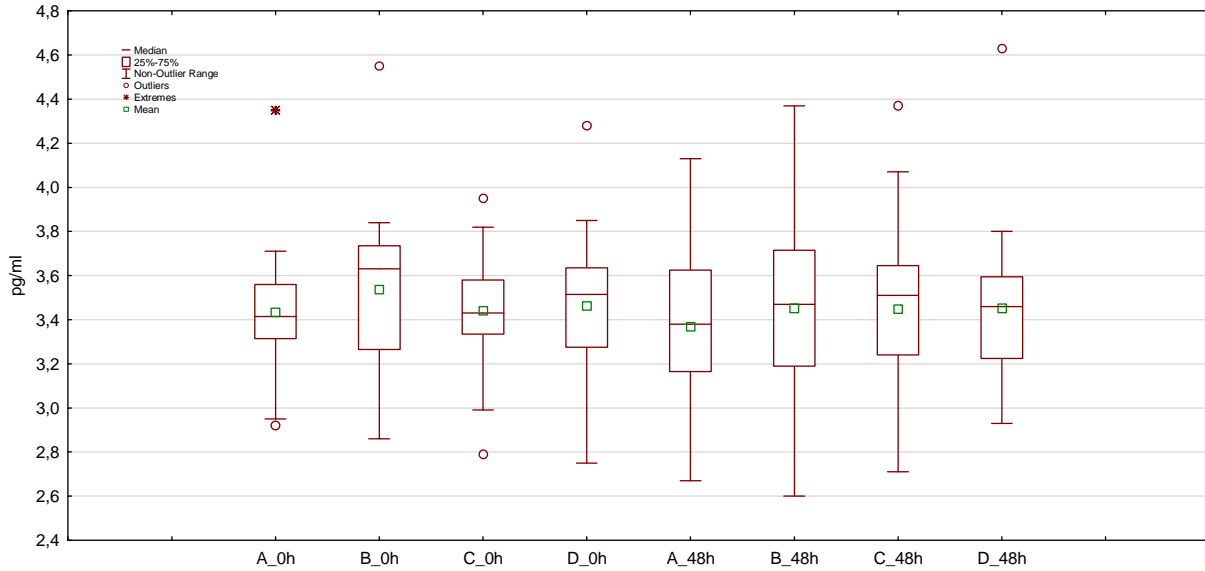
Iron (Normal Range: (m) 12.5 - 32.2 $\mu\text{mol/l}$ (f) 10.7 - 32.2 $\mu\text{mol/l}$)



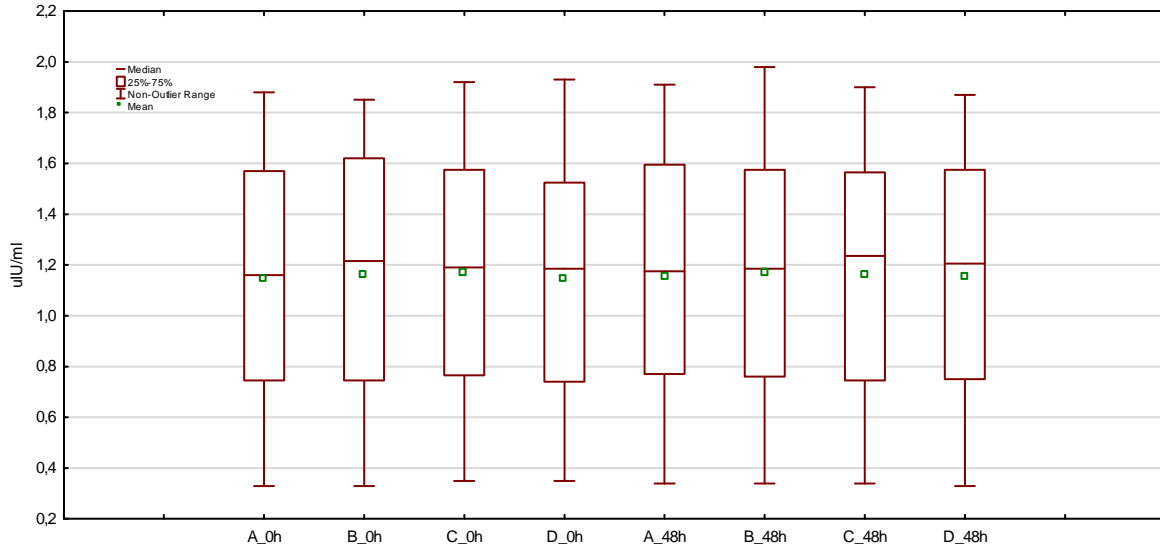
Folic Acid (Normal range: 2.3 - >24.8 ng/ml)



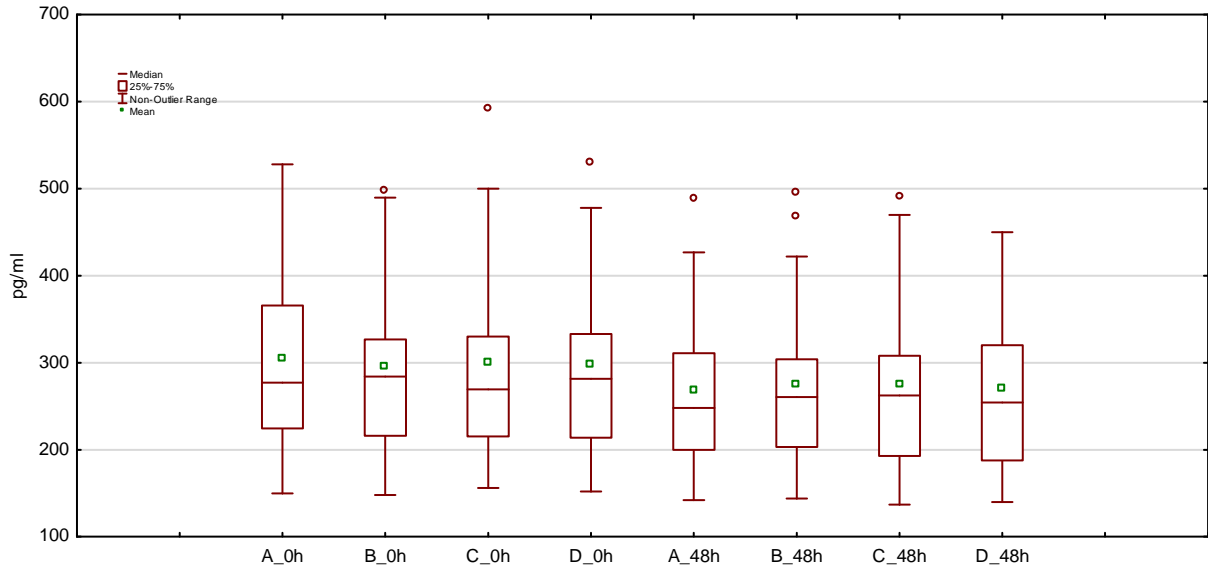
Free Triiodthyronine (Normal range: 2.5 - 3.9 pg/ml)



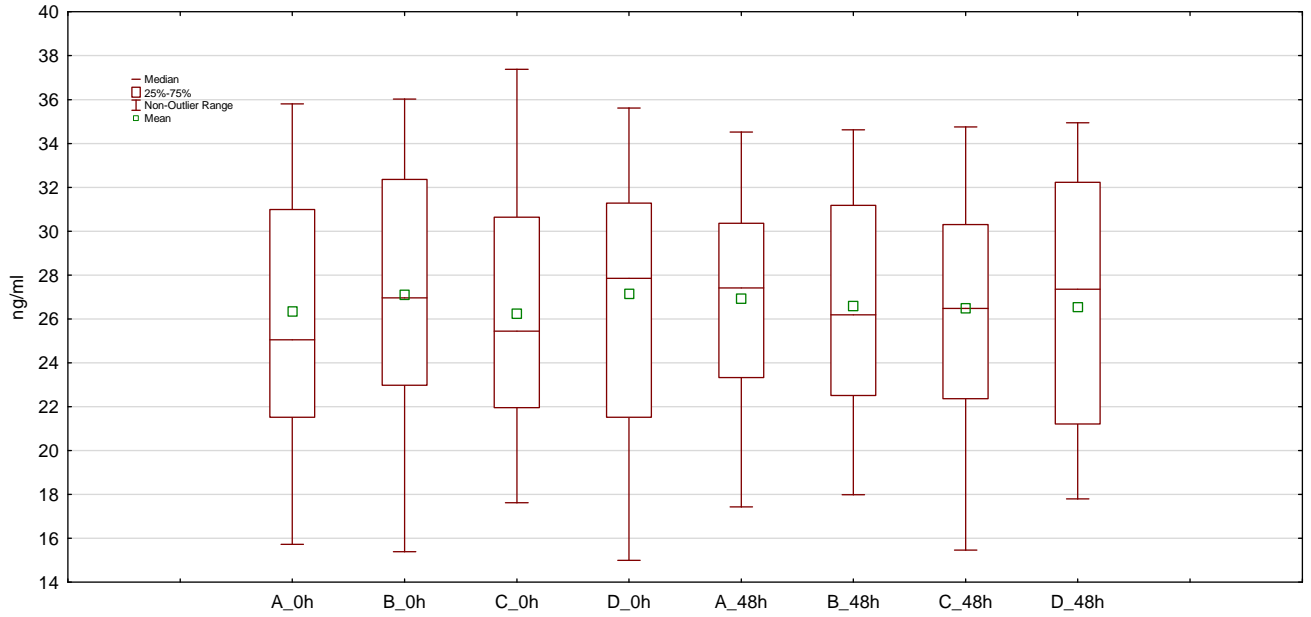
Thyroid-stimulating hormone (Hormone Normal range: 0.38 - 5.33 μ IU/ml)



Vitamin B₁₂ (Cobalamine) (Normal range: 180 - 914 pg/ml)



Vitamin D₃ (Normal range: 20 ng/ml)



Troponin I
Normal range: 0.1-0.2 µg/l

