Effects of Alkaline mineral waters on experimental Wistar rats

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Abstract

Studies on a natural therapeutic mineral water aim to obtain scientific data with which to substantiate its medical use in prevention and improving the health status of patients with various disorders. The natural mineral water used in our experiments has been recommended by physicians to treat various pathologies such as digestive disorders (chronic gastritis with hyperacidity, gastric and duodenal ulcers, chronic colitis, chronic constipation), hepatobiliary problems (biliary dyskinesia, chronic hepatitis, chronic pancreatitis, cholecystitis), associated diseases: neurasthenia, migraine disorder. These recommendations are based on the general chemical content and physical properties of the water, studied few decades ago. Natural water quality is determined generally by all mineral or organic substances, dissolved gases, particulate matter and living organisms present in it. The chemical content of the water reveals the presence of some trace minerals, such as Li or B. In the light of the new knowledge about the role of these trace elements in organism, we designed an controlled experiment to obtain data about the changes that are produced by the ingestion of the alkaline mineral water in the biological status of Wistar rats and to extrapolate our findings at the human organism.

Introduction

In the last years, it is becoming even more evident the demand of a scientific validation of crenotherapy according to the modern pharmacology and biology methods in order to give scientific dignity to the so-called therapy with mineral waters [4].

Within the system biology framework, using an array of paraclinical parameters changes to evaluate the biological status is of great importance in research regarding the role in our health status of natural mineral waters. For disease diagnostic and monitoring purposes, using a tool system that gives probabilistic outcomes and quantitative results that could be readily interpreted in biological terms represent an ideally methodical system to argue the effects of mineral water ingestion [2,3].

The concept of acid-alkaline balance explains many disease foundations, and allopathic medicine has examined pH modulation in specific organ systems such as the kidney to control the formation of stones and elimination of toxins. In order to maintain acid-alkaline balance throughout the various body systems, one system may be required to support another. For example, the bone matrix contains a substantial alkaline reserve such as calcium and magnesium cations that are released to balance an overly acidic dietary load in the event of inadequate buffering capacity in the blood [5].

Alkali supplements decrease bone resorption and increase bone mineral density. Alkali diets also lower bone resorption. Mineral waters alone could have such an effect. In several subsequent studies in humans, bicarbonate-rich alkali mineral waters with low potential acid load values were shown to decrease bone resorption markers and even parathyroid hormone levels. This seems to be stronger than that of acidic calcium-rich mineral waters and could also be demonstrated in calcium sufficiency [6].

For the most part, body tissues remain within the neutral pH of 7. Some body systems such as the blood (7.35-7.45) are more tightly regulated than others (e.g., urine pH ranges from 4.5-8.0), and any extended disturbances in acid-alkaline balance may upset cell functioning via its transport and signaling processes. The human body has several ways to regulate the acid-alkaline balance, including the cellular level via chemical reactions generating or consuming H+; blood regulating pH systems and systemically through the release of carbon dioxide from lungs and hydrogen ions from the kidney [5].

Experimental Methods

Experiments were performed on samples from laboratory animals of the species *Wistar rats,* bred under standard conditions, in adequate numbers per cage so as not to disturb the observation of each animal, temperature 21 - 22°C, conventional diet.

We selected 40 animals of the same age (12 weeks) (equal numbers of males and females) with an average weight of 100 ± 10g to form 4 experimental groups: 2 of males and 2 of females individuals: Control Group and Mineral Water Treatment Group.

During the experimental study, the experimental animals received water treatments every 24 hours, 60 ml of water, as follows:

1. Control Group experimental animals (groups 1 ♂ and 2 ♀) - received distilled water;
2. Mineral Water Group experimental animals (groups 3 ♂ and 4 ♀) - received natural mineral water

The used natural mineral water for our experimental study is a bicarbonated, hypotonic water, rich in chloride, sodium, iodine and with lithium and boron content. Water temperature was 11 °C, pH: 6.5, salinity: 5.4 g/l, electrical resistivity: 97.9527 cm W, electrical conductivity: 0.0102 cm-1W-1, dry residue at 180 °C: 6800 mg / l. Chemical composition (mg/l): Cl- 997,3; SO42- 1,8; HCO3- 5673,0; Na+ 2463,4; Ca2+193,6; Mg2+26,2; Fe2+3+ 2,0; Li+ 7,9; CO2 1540,00, Metaboric acid: 291,6 mg/l.

Our experimentally used medicinal mineral water has an acid content bicarbonate 5673 mg /l, and an amount of alkali of 6.2 mmol / L.

The most important role of K is to create and maintain the resting membrane electrical potential. Any variation in resting membrane potential causes serious problems in neuromuscular conductivity so is necessary maintaining narrow range of serum levels of K.

Normally 95% of magnesium is at the glomerulus and is reabsorbed tubularly. Serum magnesium level is dependent on diet, and along with the calcium affects parathyroid hormone level, Increase calcium reabsorption leading to competitive inhibition of magnesium absorption. When renal function is , magnesium is leading to increased serum levels.

Na + excretion by the kidneys is by changing glomerular filtration rate, serum Na +, adrenal activity, and the amount of absorbable extracellular fluid volume filtered.

Lithium level of about 8 mg per liter corresponds to a serum level, achieved by daily consumption of one liter of water, of 0.25 mM. This level is at the lower limit of the therapeutic range, and 10 times fewer than the toxic level of 2 mM, ensuring safe water consumption [8].

Boron is a trace mineral for plants, animals and humans. It probably strengthens the antioxidant defense mechanism by a yet unknown mechanism. Research findings suggest that physiological amounts of supplemental dietary boron affect a wide range of metabolic parameters in animals [6].

Analysis of experimental animals batch weight

Lots of experimental animals, Wistar rats were weighed before and after starting treatment for 24 days with 4 types of treatments. In group of males, there is a greater weight gain in the control (final average weight of 129.8 g) and the one who received the preparation of boric acid solution (final average weight of 131.8 g); in female specimens there is a greater weight gain in the control group (final average weight of 139 g) and the group that received medicinal mineral water (final average weight of 138.4 g).

Analysis of blood parameters

After water treatment, for blood sampling, the animals were sacrificed for collection of biological samples. Whole blood was collected under optimal conditions for proper dosage biochemistry parameters in biochemistry tubes (red cap on clot activator).

Serum biochemical parameters dosed were: Creatinine, Total protein, Electrolytes: Sodium, Potassium, Calcium, Magnesium and Lithium.

Determination of biochemical parameters was performed using a biochemical analyzer, Vitalab Selectra E. All the data are in table 1.

v Creatinine

Serum Creatinine values showed similar between groups, with a higher average value in control groups (0.3 mg / dl in males and 0.27 respectively mg / dl in females).

v Serum total protein

Serum total protein values are highly similar between both groups of males and females and between groups that received different treatments, which demonstrates that the types of Wistar rats given water or laboratory prepared solutions does not influence this parameter. The difference between the mean triglyceride in group consumed medicinal mineral water in excess of the witness is of 0.11 mg / dl.

v Serum sodium

Serum sodium values vary between lots of very small experimental animals. Sodium values follow a trend similar to lots of male and female animals.

v Potassium

Serum potassium levels vary between groups and follow a different trend in the group of males from the females. Recorded higher values in female animals of the group that received Special Solution, 1.3 mg / dl higher than the control group and in a lot of males in the control group, with about 1.5 mg / dl higher than the other groups.

v Serum calcium

Serum calcium values are on average 0.56 mg / dl higher in male than in female individuals. For males lots, the highest value was recorded in the group receiving Special Solution, ie 1.52 mg / dl than in the control group. In groups of rats receiving medicinal mineral water, serum calcium values are 0.42 mg / dl more than in the control group and by 1.27 mg / dl in the group that received Special Solution.

v Serum magnesium

Serum magnesium values are different from male and female specimens with 0.12 mg / dl higher in groups of females. In groups of females receiving medicinal mineral water, serum magnesium values are 0.08 mg / dl more than in the control group and 0.11 mg / dl than in the group receiving Special Solution.

v Lithium

Lithium blood values of laboratory rats are slightly higher in females (0.01 mg / dl) in all groups. Within lots of males in the control group values are 0.02 mg / dl lower than the other, and in a lot of females who received the medicinal mineral water, values are 0.01 mg / dl higher than in other groups.

Analysis of urine samples

Brief examination of urine is a easy test that can be used to achieve especially kidney disease, urological evaluation. Summary urine was made from urine collected in the morning of each individual in lots of experimental animals-Wistar rats.

Biochemistry

v Urinary Creatinine

Experimental animal urine Creatinine values vary widely both between groups receiving different treatments and between batches of different sexes. Note that Creatinine values in laboratory animals that consumed boric acid is much higher than all other groups, with 12.91 mg/dl higher than for individuals males in the control group and 14.32 mg/dl higher than the control group for females. The test appreciates deterioration of renal function, Creatinine level indicating glomerular filtration rate.

v Urinary protein

Under normal circumstances, urine containing only traces amounts of protein. They are by a combination of plasma-derived proteins that have been filtered by glomeruls and tubules were by the proximal as well as proteins secreted by renal tubules or glands accessories.

Total protein in urine does not show the same trend between experimental animal groups in the two sexes, but average values are similar, ranging between 0.3 to 1.06 mg / dl. The highest values are in the groups who consumed preparation boric acid, 1.06 mg / dl in the group of males and 0.92 mg / dl in the group of females.

v Urinary sodium

The main route of sodium elimination is renal. The amount of Na + that appears in the urine represents the difference between the amount filtered glomeruls and is reabsorbed in the tubular lumen. Urinary excretion of Na + is often only about 1% of the amount filtered.

Urine sodium values are different from the 4 types of experimental animal groups. Values recorded in male animals are 15.27 mg / dl lower than in females. The values obtained for the group of control animals are considerably lower than in all other groups, ie 26 mg / dl in males lots and about 40 mg / dL for females.

v Urinary potassium

The largest amount of potassium is through the kidneys, excretion of K + varies in very wide limits, depending on the input. Potassium excretion depends solely on filtration and secretion processes. Decreased levels of potassium in renal tubular cells require deviation sodium ion exchange via H + / Na +. In this way produces removing excess hydrogen ions, the urine becomes acidic and body fluids develop a metabolic alkalosis.

Urine potassium levels are much higher than those recorded in the blood. Much higher values were obtained for groups of experimental animals received boric acid, ie 14.35 mg / dl in males and about 34.85 mg / dl in a lot of females.

v Urinary magnesium

Urinary magnesium values follow the same trend in groups of males and females. The highest values were recorded in the groups that received Special Solution with 0.58 mg/dl more than in the males control group and 0.92 mg / dl more than in the females control group. Serum magnesium values of laboratory animals, however, are lower for these groups, which show that although Special Solution contains a similar magnesium level, it is in urine in a high proportion. If magnesium is ingested through medicinal mineral water, magnesium levels are higher in blood than in urine, which means a more efficient absorption.

v Urinary calcium

Most of calcium is in faeces, and a small amount of calcium excreted in the urine, according to calcium intake in the diet. Increased urinary calcium resulting from increased intestinal absorption, decreased tubular reabsorption, or loss of bone calcium resorption and almost always accompanies high levels of calcium in the blood. When calcium is in large amounts, favors the production of nephrolithiasis and nephrocalcinosis, especially if associated with increased protein intake. Determination of urinary calcium is critical in diagnosis of hypercalcemia responsible for the occurrence of kidney stones.

Urinary calcium values vary widely between batches of experimental animals. As with magnesium, the highest values were recorded in the group that received Special Solution, ie 1.49 mg / dl rather than in the males control group and 11.73 mg / dl more than the females control group.

v Urinary lithium

Variation of lithium in urine is trending similar to lots of male and female experimental animals. The highest values of lithium in urine were recorded in the groups receiving medicinal mineral water, ie 0.04 mg/dl rather than in the males control group and 0.06 mg/dl more than for females in the control group, demonstrating high lithium elimination in the urine.

Microscopic examination of urinary sediment reveals differences in the appearance of urinary sediment derived from experimental animal groups that received different treatments.

Discussion and conclusions

Adequate fluid replacement helps maintain hydration and, promotes the health, safety, and optimal physical performance of individuals [1].

The results of our study can be regarded as terms for a mathematical matrix and the global picture can be mathematically interpreted as a solution for this kind of function. Unfortunately, for this moment is difficult to select the appropriate paraclinical parameters to really challenge this problem. Our hypothesis is based only on the title of the article of Ellis et al from 2007: Metabolic fingerprinting as a diagnostic tool [2]. Starting from here, we gathered the data in one value, without taking in account for standard deviation of results. This value obtained was after divided to the number of paraclinical parameters evaluated. The results are in table 2 for all 19 parameters, table 3 with 11 serum parameters and table 4 with 8 urine parameters.

In this way, our discussion become more objective, speaking only in numbers, associated with biological status influenced only by the type of water ingested, considering the assumption that all other conditions are the same for the experimental animals in various lots. So, we can observe that the biological status of animals in the males control group is 20,11 and 20,39 for females, this index become higher in case of mineral water ingestion (21,24 and 21,57) and boric acid consumption (21,73 and 26,74), mean while the index is similar to control in the case of special solution treatment for males (20,31) but higher for females (22,97). From here we can have a first conclusion: mineral water and boric acid influence the original biological status of animals interpreted through the value explained above.

For blood samples, the results managed in the same manner show the opposite: the index is lower in the case of mineral water ingestion (21,68 and 22,42) then in the control case (23,05 and 22,95), but the situation is for urine parameters. These findings offer us an explanation about the adaptability of the animal organisms and the mechanisms involved in the electrolytic balance.

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Tabel 1. Changes in biological status of Wistar rats induced by ingestion of a natural alcaline mineral water

Parameter	Control Group ♂	Control Group ♀	Water Group ♀	Water Group ♂
Serum creatinine	0,30±0,04	0,27±0,04	0,24±0,04	0,27±0,04
Serum total protein	7,07±0,08	7,06±0,08	6,93±0,08	6,96±0,08
Serum Sodium	121,20±3,26	116,37±3,26	117,30±3,26	118,37±3,26
Serum potassium	4,10±0,58	6,00±0,58	4,77±0,58	4,73±0,58
Serum calcium	9,97±2,10	9,20±2,10	9,62±2,10	9,66±2,10
Serum magnesium	2,05±0,12	2,21±0,12	2,29±0,12	2,08±0,12
Serum lithium	0,04±0,02	0,08±0,02	0,09±0,02	0,07±0,02
Urinary creatinine	14,22±5,96	19,36±5,96	13,18±5,96	21,70±5,96
Urinary protein	0,44±0,07	0,57±0,07	0,3±0,07	0,89±0,07
Urinary sodium	59,1±3,2	59,5±3,2	92,1±3,2	85,05±3,2
Urinary potassium	21,75±0,55	22,3±0,55	28±0,55	27,55±0,55
Urinary calcium	2,66±2,1	4,02±2,1	0,74±2,1	3,79±2,1
Urinary magnesium	2,11±0,02	1,92±0,02	1,95±0,02	1,98±0,02
Urinary lithium	0,02±0,02	0,021±0,02	0,078±0,02	0,039±0,02

Fig 1. Wistar rats / experimental design

Males rats	Weight (g)	
	Before	After
Control	108	113
	107	125
	106	132
	112	133
	90	146
Water	111	130
	101	135
	100	128
	116	120
	116	116
Watersol	113	116
	112	143
	103	126
	116	126
	106	127
Bor	112	116
	118	144
	126	134
	104	123
	106	142

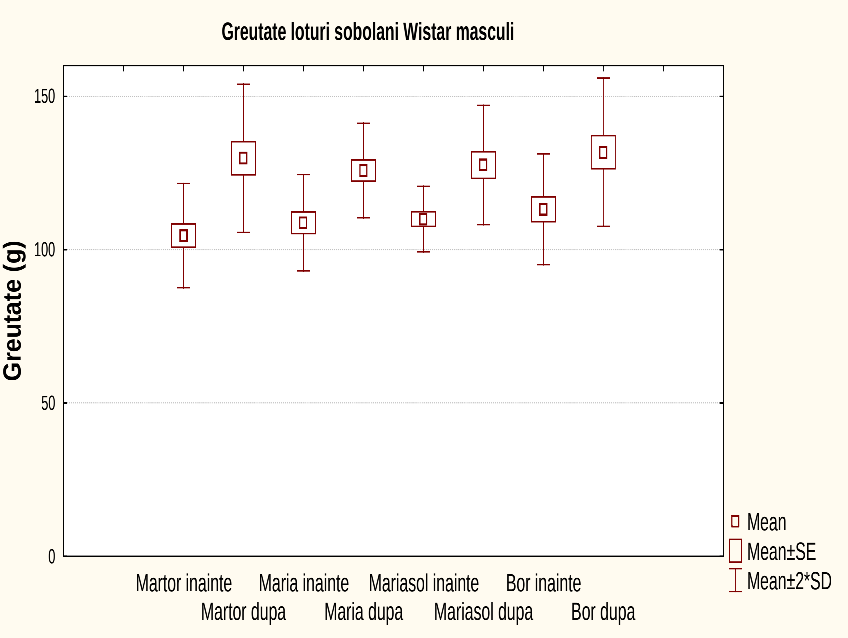


Fig. 2. Average weight groups-males Wistar rats before and after treatment with 4 types of water

Females rats	Weight (g)	
	Before	After
Control	120	128
	108	143
	123	153
	113	135
	112	136
Water	108	138
	119	143
	118	132
	118	133
	116	146
Watersol	111	126
	108	124
	94	120
	102	131
	98	110
Bor	98	127
	113	135
	110	120
	96	124
	98	121

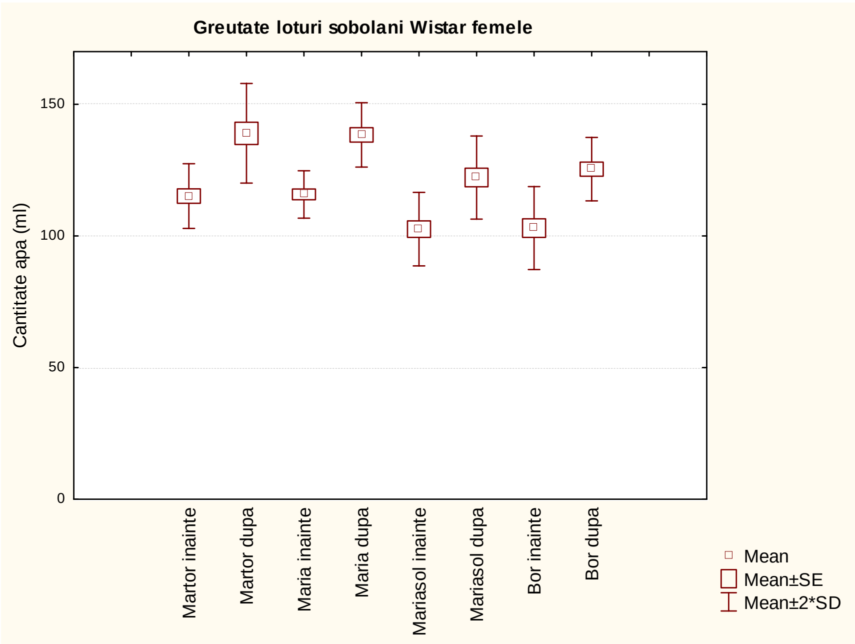
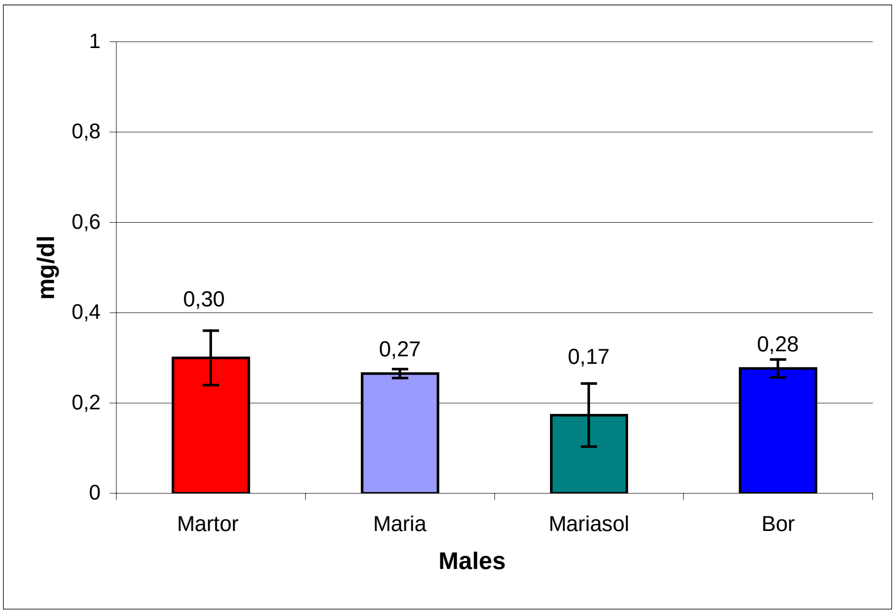


Fig. 3. Average weight groups-females Wistar rats before and after treatment with 4 types of water

SERUM CREATININE	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	0,28	0,26	0,09	0,26	0,27	0,27	0,26	0,21
2	0,22	0,27	0,2	0,31	0,22	0,23	0,23	0,28
3	0,38	0,28	0,23	0,26	0,33	0,2	0,25	0,28
4	0,32	0,25			0,24	0,27	0,3	0,19
Media	**0,30**	**0,27**	**0,17**	**0,28**	**0,27**	**0,24**	**0,26**	**0,24**
Stdev	0,07	0,01	0,07	0,03	0,05	0,03	0,03	0,05



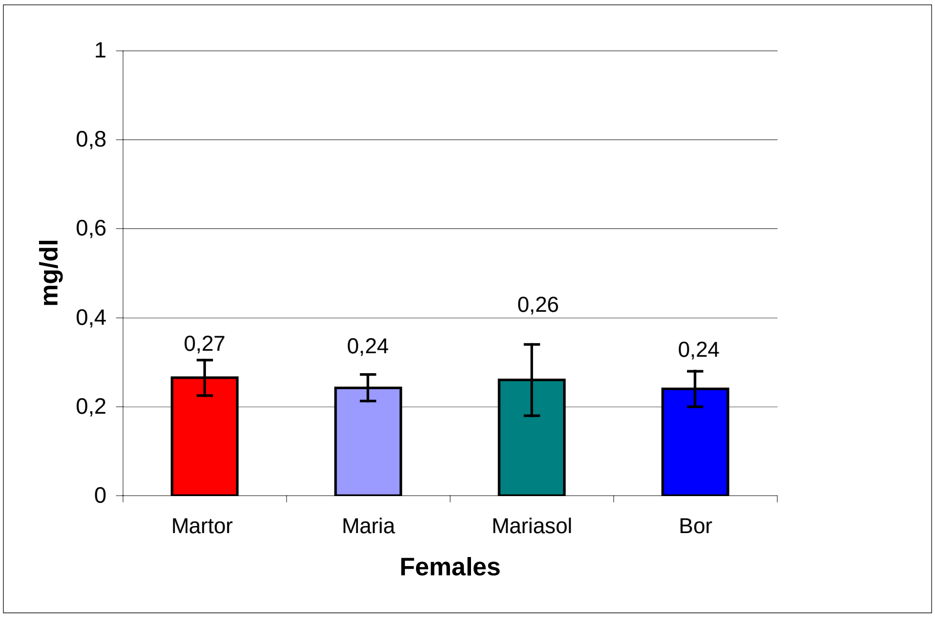
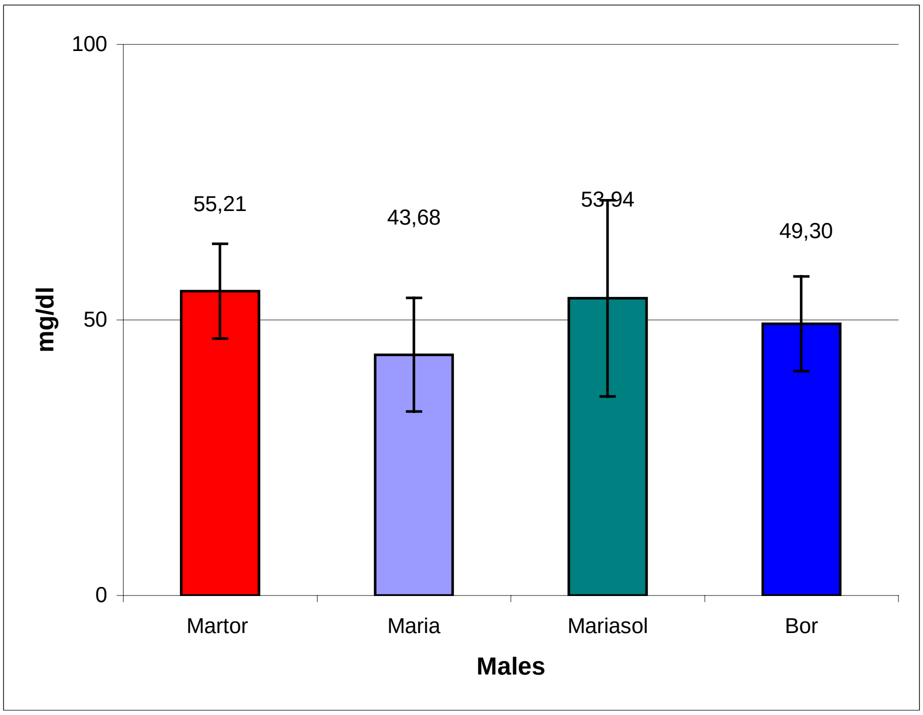


Fig. 4. Variation of serum creatinine in groups of experimental animals

SERUM CHOLESTEROL	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	63,59	58,73	74,52	59,1	50,24	30,06	56,96	58,54
2	60,52	41,77	43,96	42,62	42,76	42,73	43,84	50,16
3	52,25	35,73	43,33	46,18	49,82	39,17	35,07	46,56
4	44,47	38,5			36,86	43,26	44,5	50,82
medie	**55,21**	**43,68**	**53,94**	**49,30**	**44,92**	**38,81**	**45,09**	**51,52**
stdev	8,61	10,33	17,83	8,67	6,38	6,11	9,00	5,04



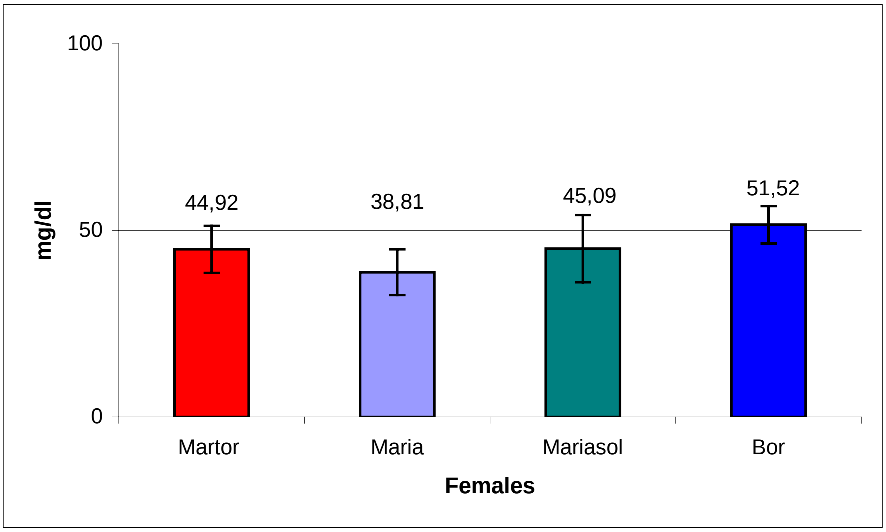
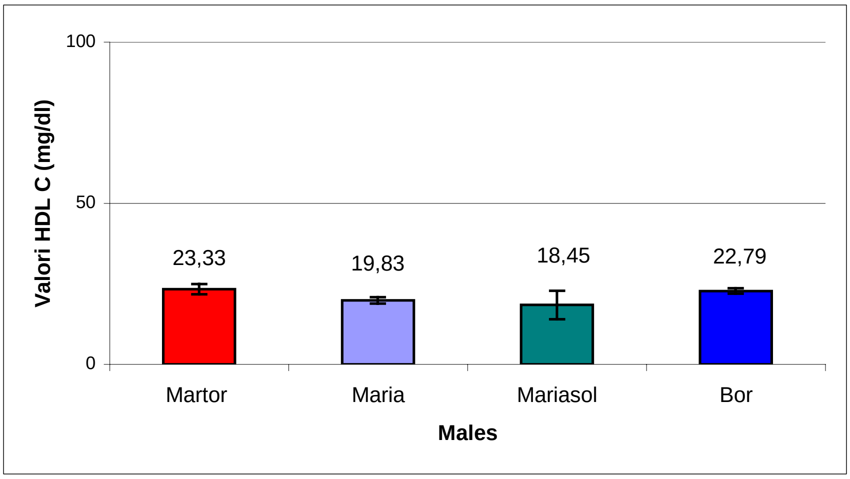


Fig. 5. Cholesterol Variation in groups of experimental animals

HDL Cholesterol	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	24,43	19,88	21,6	22,17	16,25	14,61	21,55	26,67
2	24,1	20,89	15,3	23,41	18,94	22,22	19,89	22,4
3	21,47	20,07			22,41	18,46	14,06	21,28
4		18,46			17,12	20,53	15,72	22,18
medie	**23,33**	**19,83**	**18,45**	**22,79**	**18,68**	**18,96**	**17,81**	**23,13**
stdev	1,62	1,01	4,45	0,88	2,73	3,28	3,50	2,41



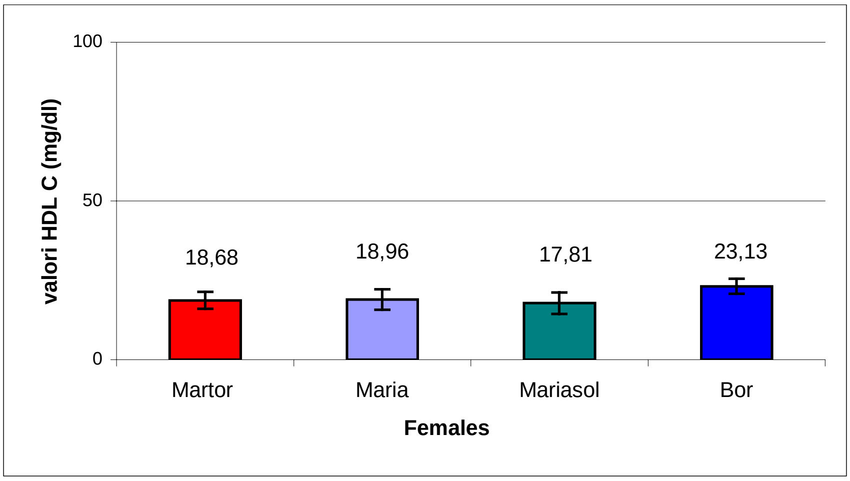
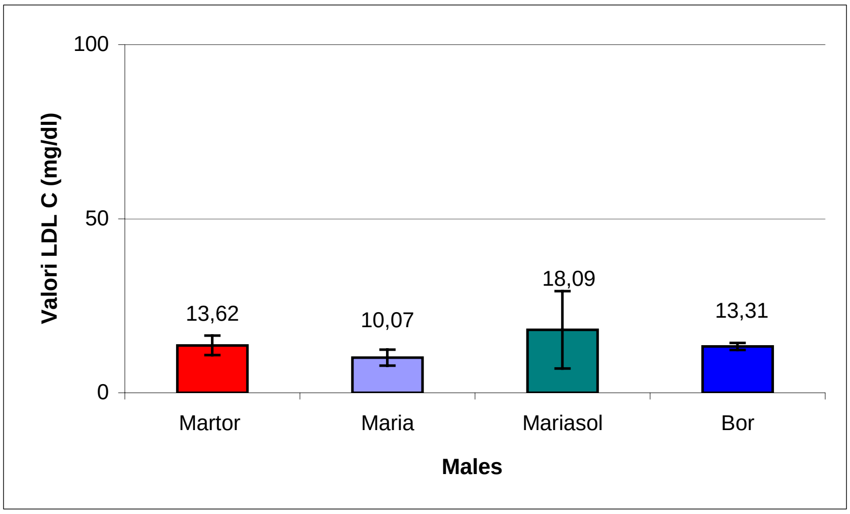


Fig.6. HDL Cholesterol variation in groups of experimental animals

LDL Cholesterol	**Control males**	**Water males**	**Watersol males**	**Bor males**	**Control females**	**Water females**	**Watersol females**	**Bor females**
1	16,86	13,45	25,95	14,08	11,89	6,6	10,77	15,96
2	11,78	9,59	10,23	12,53	12,25	11,32	10,9	10,85
3	12,21	9,19			12,99	9,31	9,49	
4		8,04			9,58	10,52	9,82	
medie	**13,62**	**10,07**	**18,09**	**13,31**	**11,68**	**9,44**	**10,25**	**13,41**
stdev	2,82	2,35	11,12	1,10	1,47	2,06	0,70	3,61



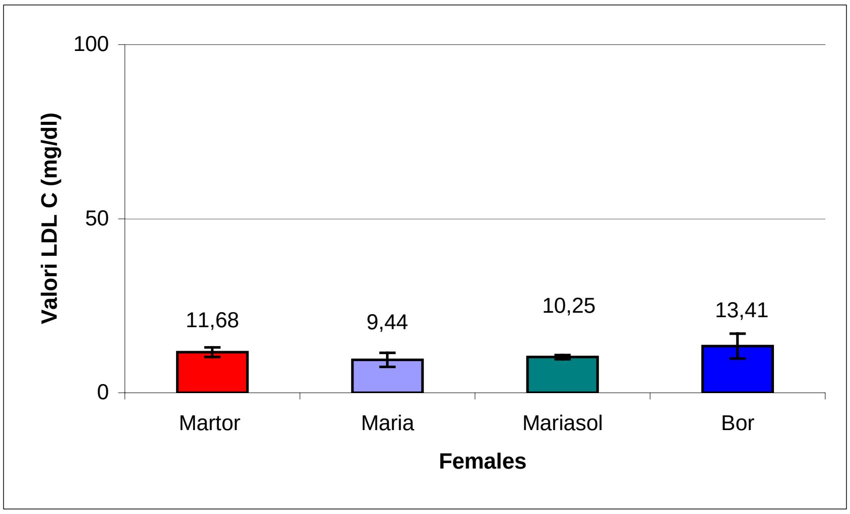
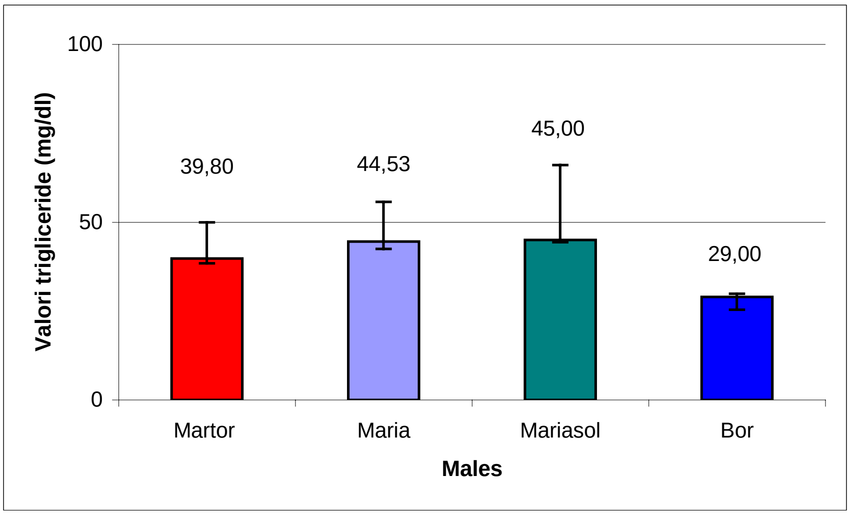


Fig. 7. LDL Cholesterol variation in groups of experimental animals

SERUM TRYGLICERIDS	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	38,5	38	69,1	28,3	43,7	40,4	62,5	69,5
2	49,3	40,3	29,8	29,7	63,2	93,5	62,9	41,1
3	45,5	61,4	36,1		73,3	48,9	44,2	88,8
4	25,9	38,4			55,8	59,7	43,1	65,7
medie	**39,80**	**44,53**	**45,00**	**29,00**	**59,00**	**60,63**	**53,18**	**66,28**
stdev	10,29	11,29	21,11	0,99	12,47	23,30	11,01	19,59



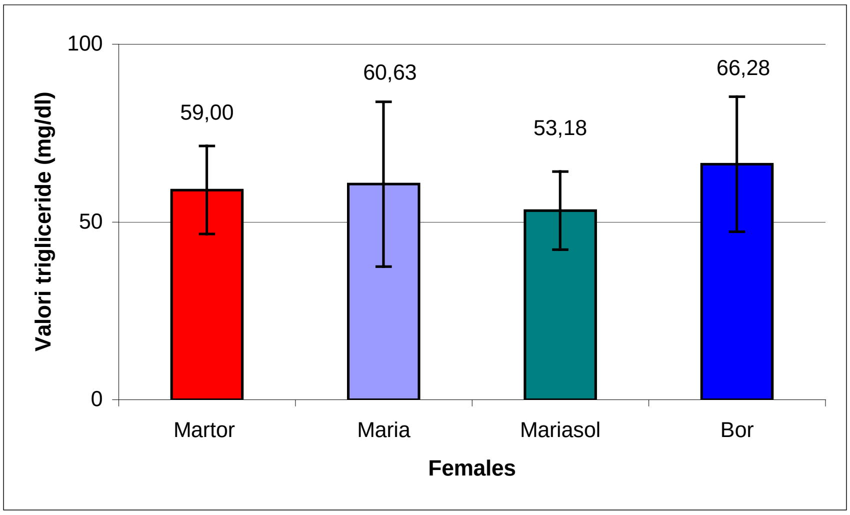
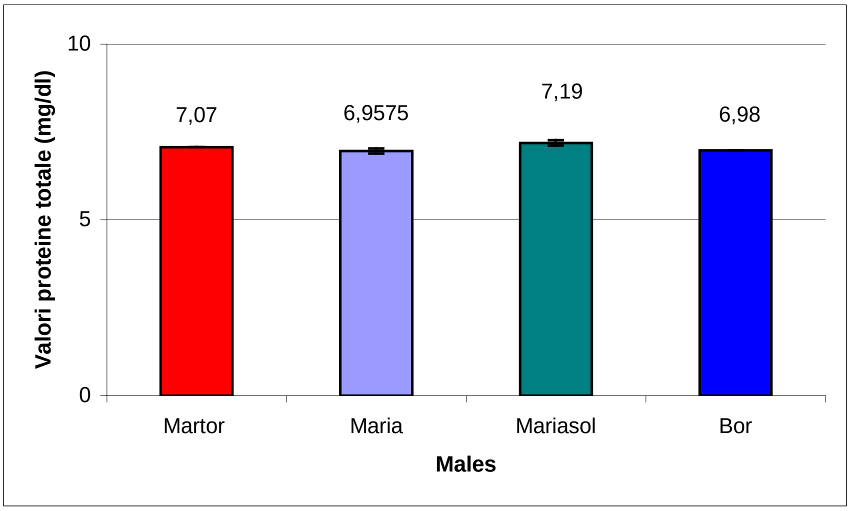


Fig. 8. Variation of triglycerides in experimental animal groups

SERUM TOTAL PROTEINS	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	7,07	6,85	7,25	6,98	7,06	7,04	7,04	7,15
2		6,97	7,13			6,9	6,99	6,99
3		7,02				6,8	6,98	6,99
4		6,99				6,96	7,04	6,89
medie	**7,07**	**6,96**	**7,19**	**6,98**	**7,06**	**6,93**	**7,01**	**7,01**
stdev		0,07	0,08			0,10	0,03	0,11



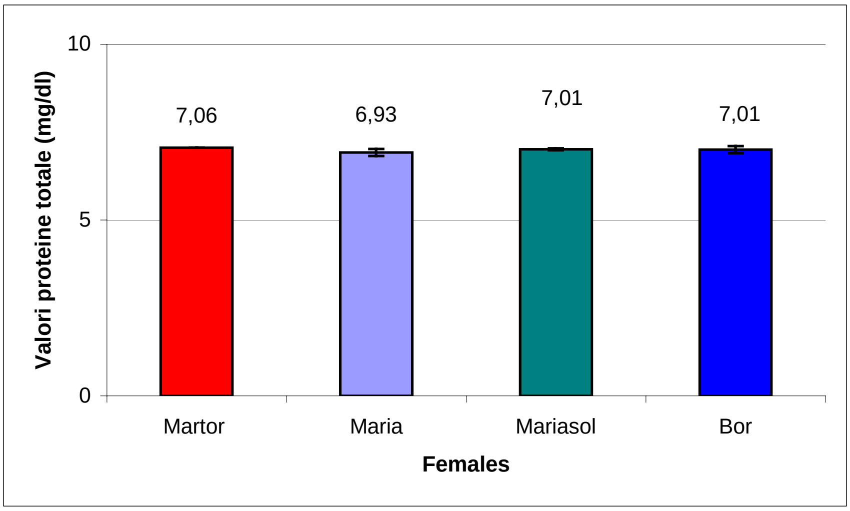
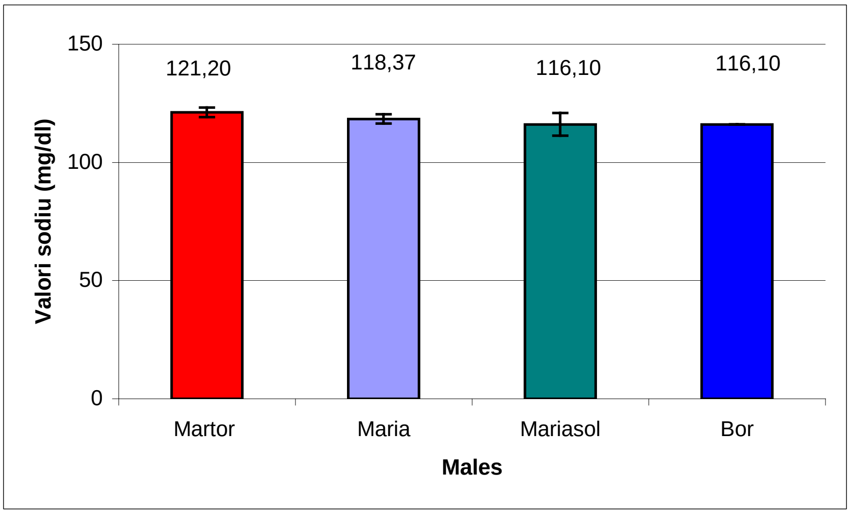


Fig. 9. Variation of total protein in experimental animal groups

SERUM SODIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	119,5	119,5	112,7	116,1	116,1	113,5	117,3	109,7
2	122,9	119,5	119,5	116,1	119,5	121,1	113,5	113,5
3		116,1			113,5	117,3	113,5	124,9
4								
medie	**121,20**	**118,37**	**116,10**	**116,10**	**116,37**	**117,30**	**114,77**	**116,03**
stdev	2,40	1,96	4,81	0,00	3,01	3,80	2,19	7,91



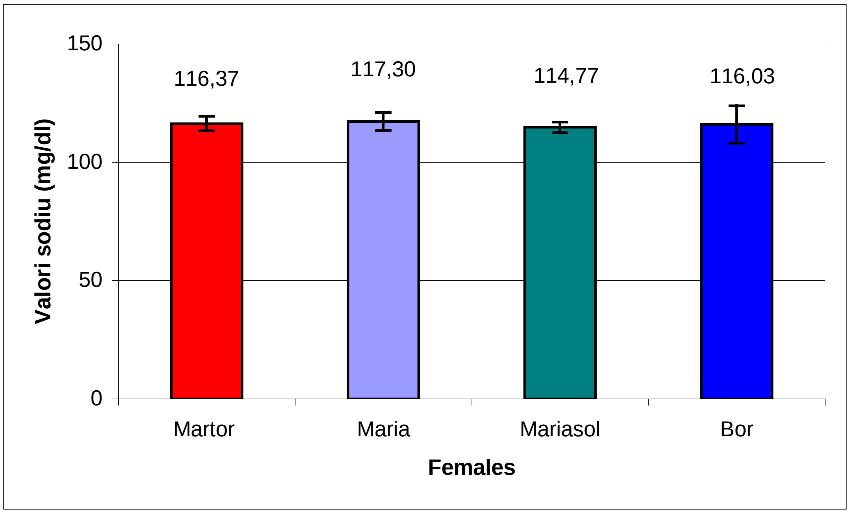
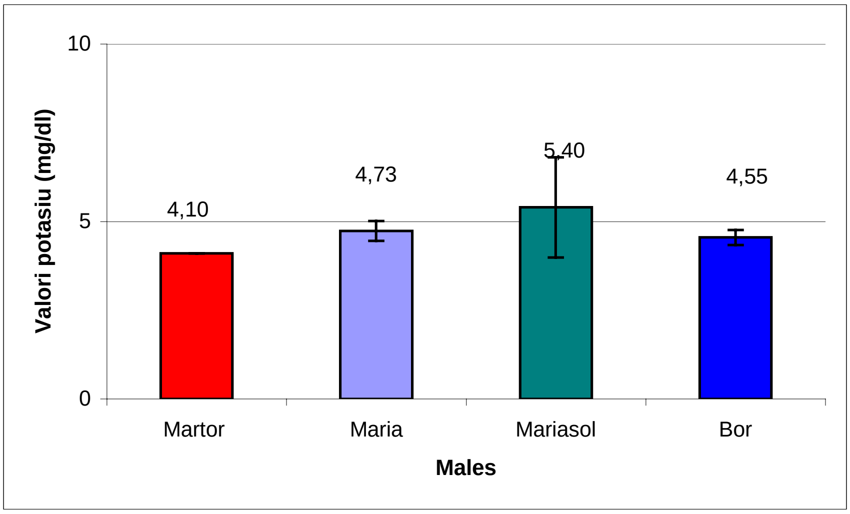


Fig. 10. Variation of serum sodium in experimental animal groups

SERUM POTASIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	4,1	4,4	4,4	4,4	5,3	4,2	3,9	4,1
2	4,1	4,9	6,4	4,7	6	5,9	5,6	4,4
3		4,9			6,7	4,2	5,5	4,2
4								
medie	**4,10**	**4,73**	**5,40**	**4,55**	**6,00**	**4,77**	**5,00**	**4,23**
stdev	0,00	0,29	1,41	0,21	0,70	0,98	0,95	0,15



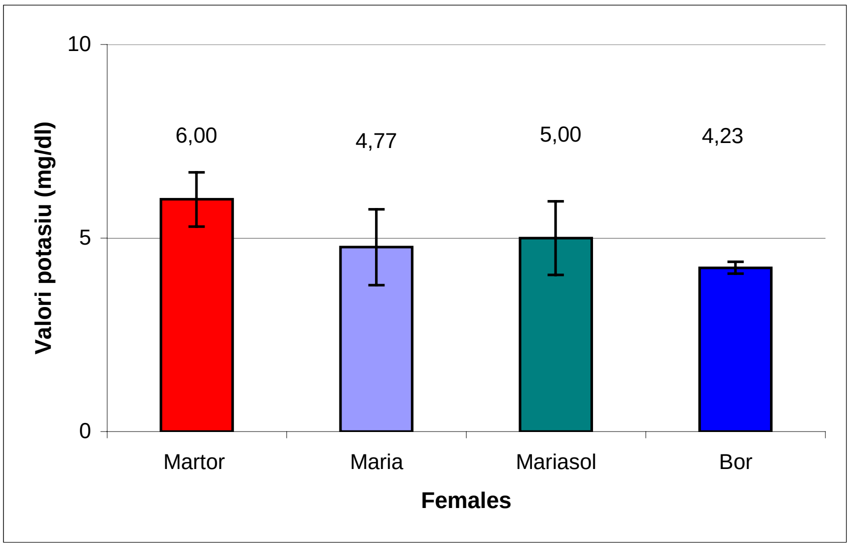


Fig. 11. Variation of serum potassium in experimental animal groups

CALCIUM SERIC	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	12,18	11,79	16,56	10,52	11,38	12,4	9,75	12,23
2	9,28	8,02	9,46		8,47	8,79	7,92	
3	8,46	9,98	8,45		8,06	8,87	7,39	
4		8,85			8,87	8,43		
medie	**9,97**	**9,66**	**11,49**	**10,52**	**9,20**	**9,62**	**8,35**	**12,23**
stdev	1,95	1,63	4,42		1,49	1,86	1,24	

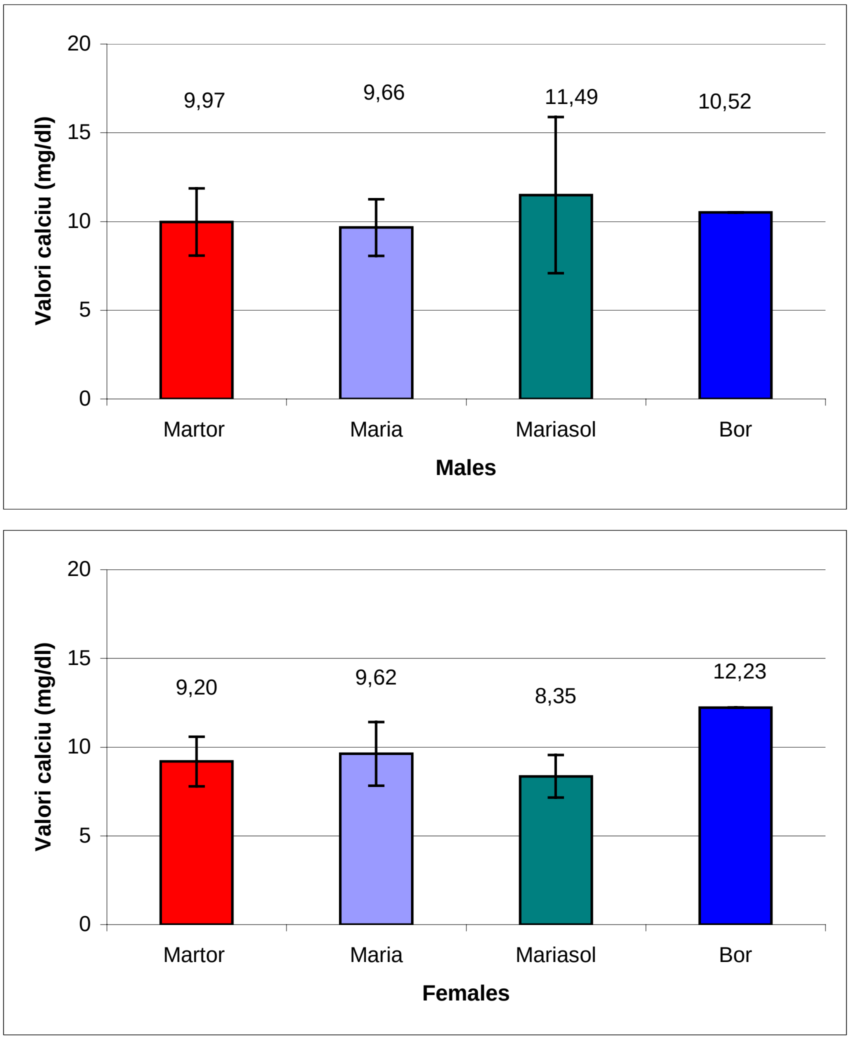
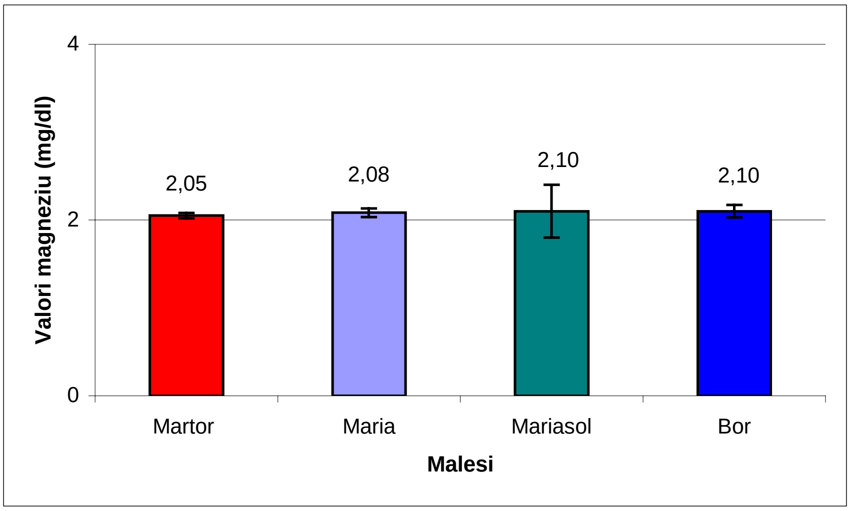


Fig. 12. Variation of serum calcium in experimental animal groups

SERUM MAGNEZIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	2,05	2,06	1,84	2,05	2,16	2,12	2,14	2,06
2	2,03	2,02	2,36	2,15	2,29	2,21	2,19	2,12
3	2,1	2,09			2,18	2,56	2,2	2,28
4	2,02	2,16			2,2	2,25	2,17	2,33
medie	**2,05**	**2,08**	**2,10**	**2,10**	**2,21**	**2,29**	**2,18**	**2,20**
stdev	0,04	0,06	0,37	0,07	0,06	0,19	0,03	0,13



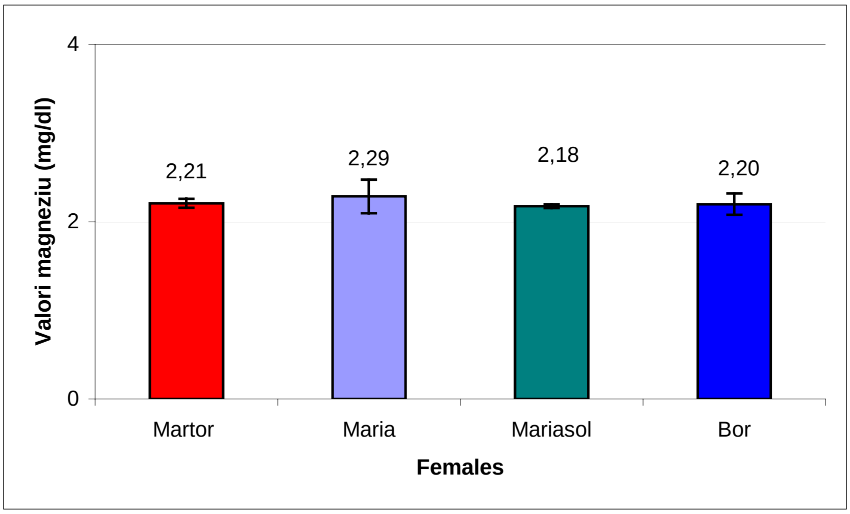
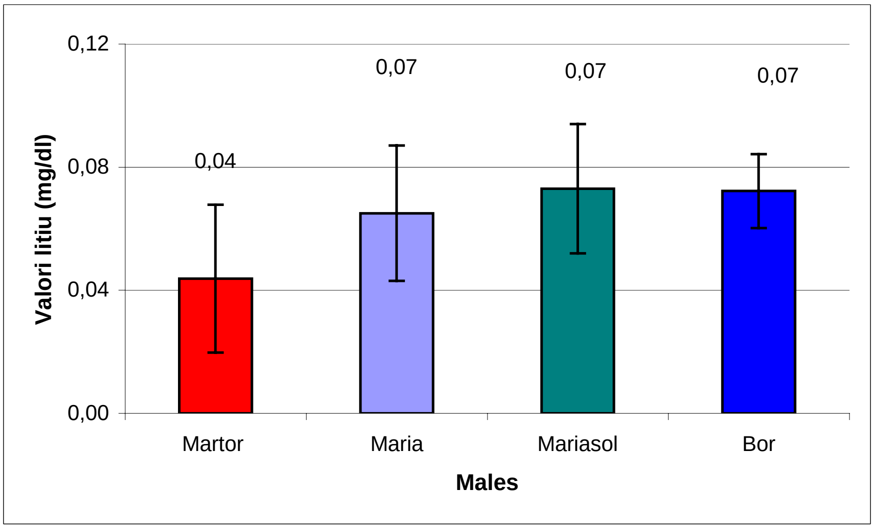


Fig. 13. Variation of serum magnesium in experimental animal groups

LITHIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	0,037	0,073	0,08	0,075	0,098	0,104	0,104	0,085
2	0,062	0,044	0,062	0,056	0,098	0,085	0,089	0,076
3	0,012	0,05	0,051	0,085	0,09	0,092	0,081	0,08
4	0,064	0,093	0,099	0,073	0,042	0,068	0,039	0,07
medie	**0,04**	**0,07**	**0,07**	**0,07**	**0,08**	**0,09**	**0,08**	**0,08**
stdev	0,02	0,02	0,02	0,01	0,03	0,02	0,03	0,01



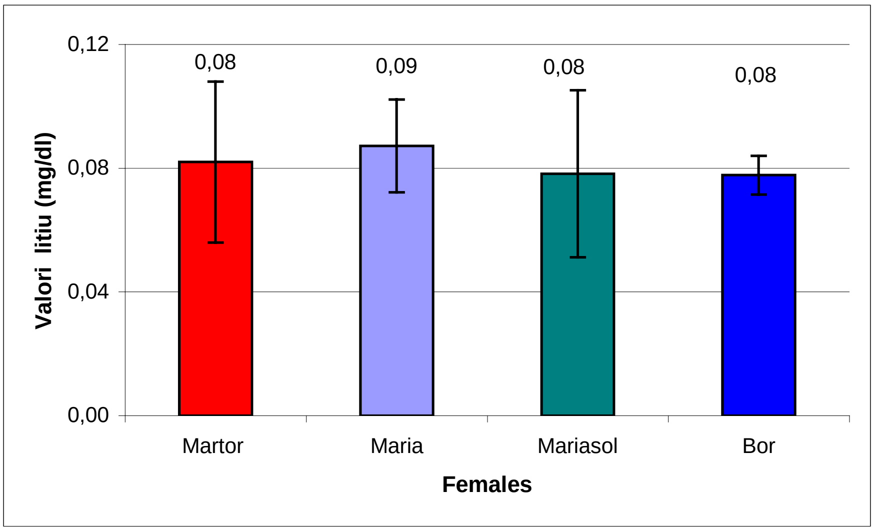


Fig. 14. Variation of lithium in experimental animal groups

URINARY CREATININE	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	8,79	23,91	7,13	21,95	16,13	12,5	5,86	25,48
2	19,65	19,49	9,21	30,86	22,59	13,86	22,82	41,87
medie	**14,22**	**21,70**	**8,17**	**26,41**	**19,36**	**13,18**	**14,34**	**33,68**
stdev	7,68	3,13	1,47	6,30	4,57	0,96	11,99	11,59

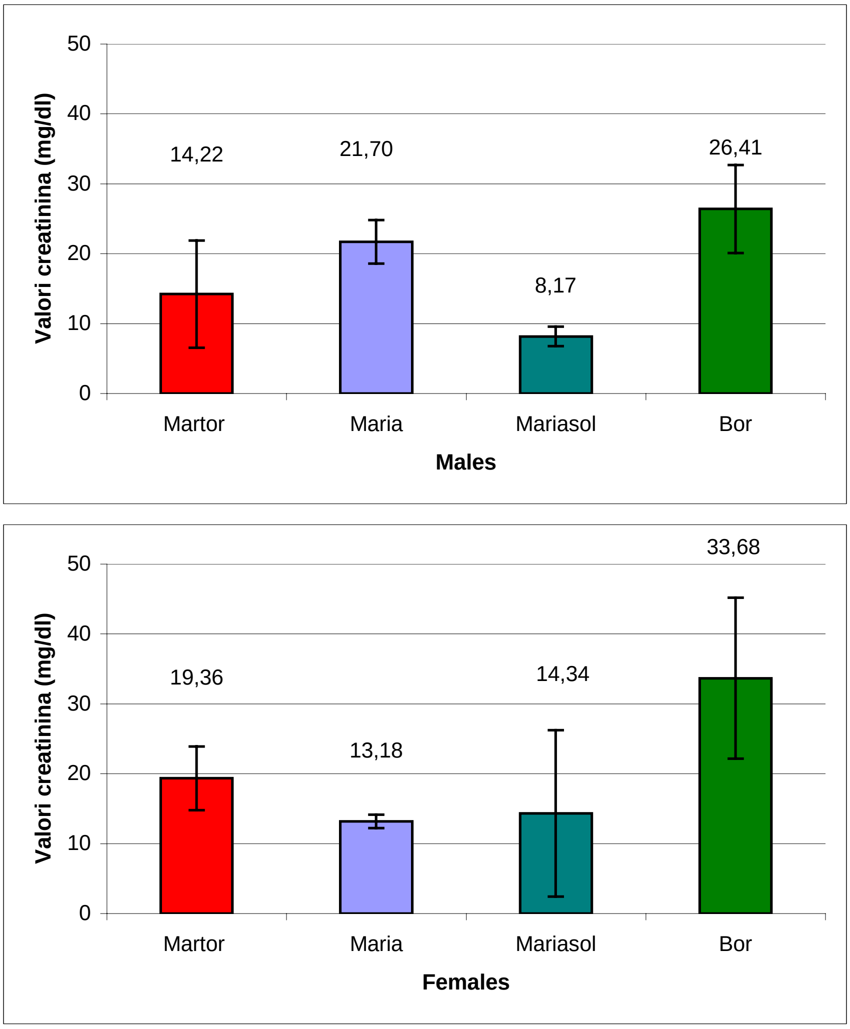
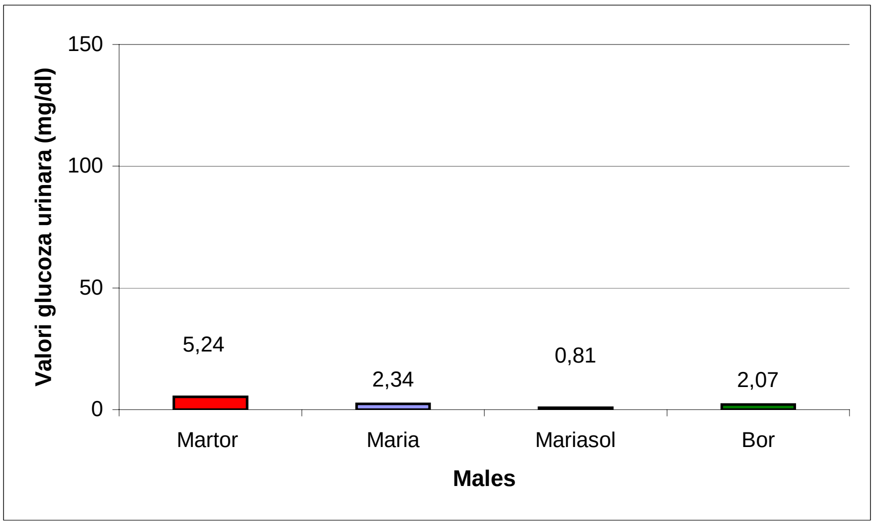


Fig. 15. Variation of urinary creatinine in experimental animal groups

URINARY GLUCOSE	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	1,78	4,65	1,51	4	5,14	4,6	1,92	5,11
2	8,69	0,03	0,11	0,14	3,35	4,34	0,02	5,07
medie	5,24	2,34	0,81	2,07	4,25	4,47	0,97	5,09



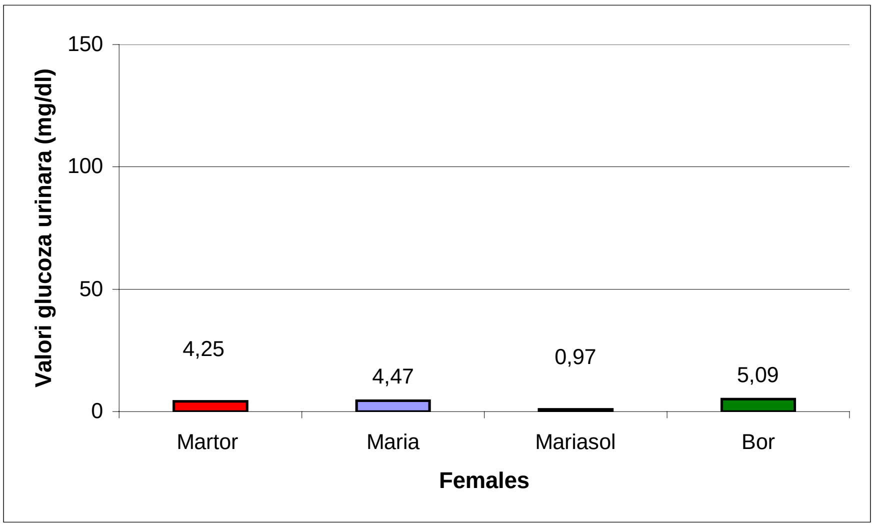
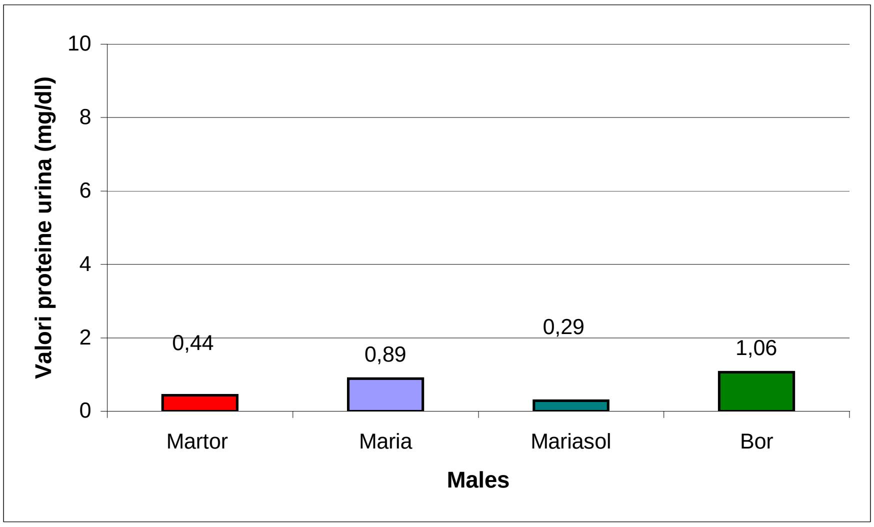


Fig. 16. Variation of glucose in the urine of experimental animal groups

URINARY PROTEINS	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	0,39	1,07	0,27	1,15	0,61	0,38	0,14	0,55
2	0,49	0,71	0,3	0,97	0,53	0,22	1,56	1,29
medie	0,44	0,89	0,285	1,06	0,57	0,3	0,85	0,92



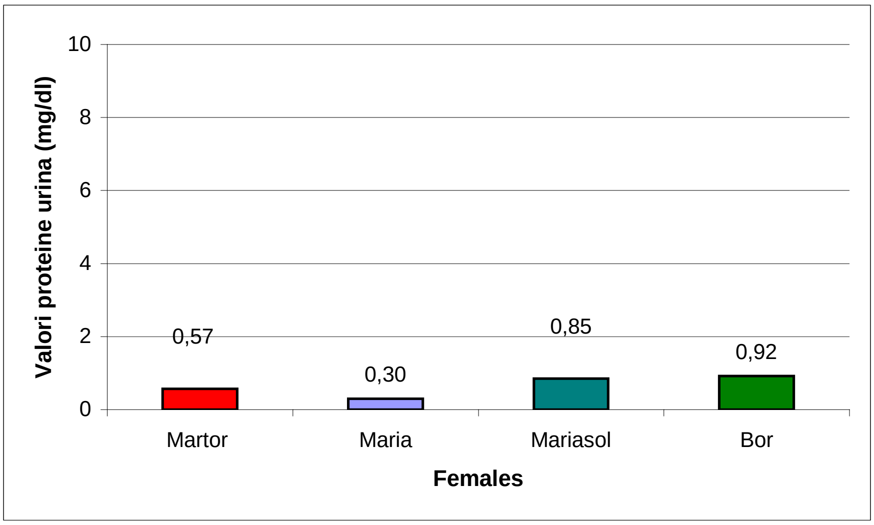
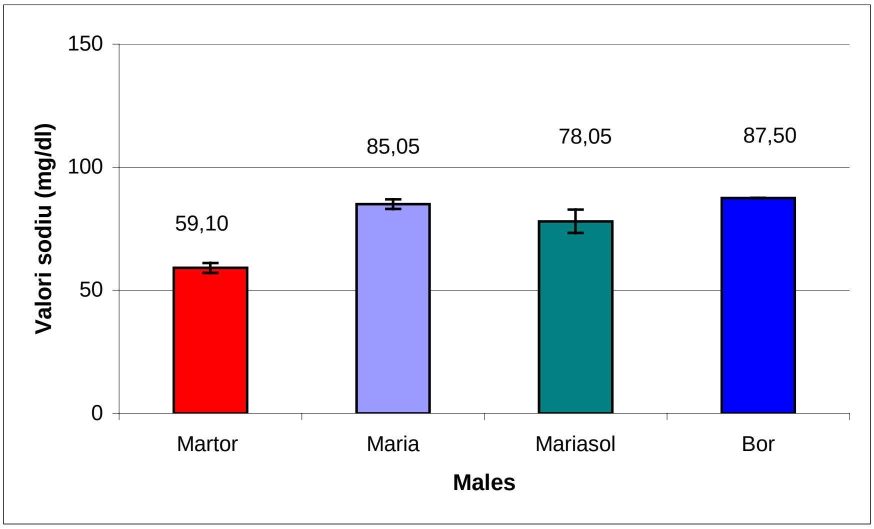


Fig. 17. Variation of protein in the urine of experimental animal groups

URINARY SODIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	36,6	82,3	77,7	77,7	59,4	86,9	96	91,4
2	81,6	87,8	78,4	97,3	59,6	97,3	134,9	116,1
medie	59,1	85,05	78,05	87,5	59,5	92,1	115,45	103,75



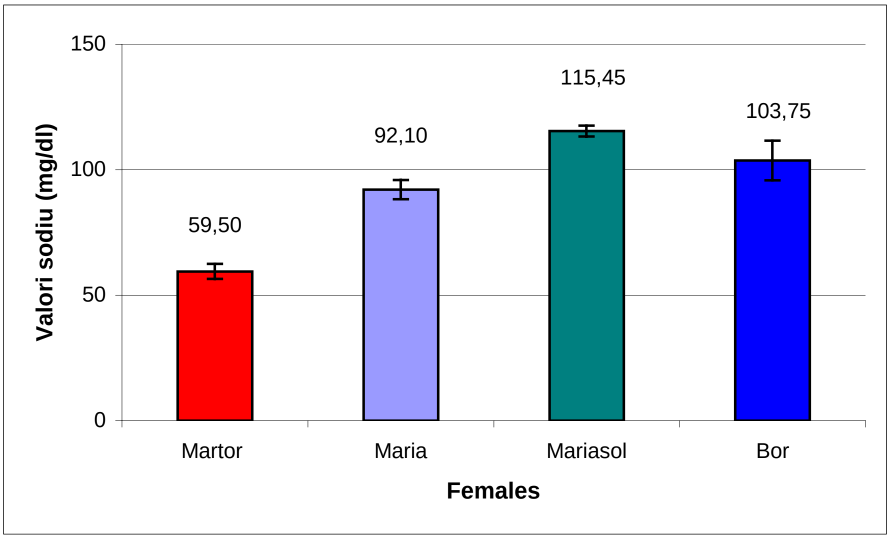
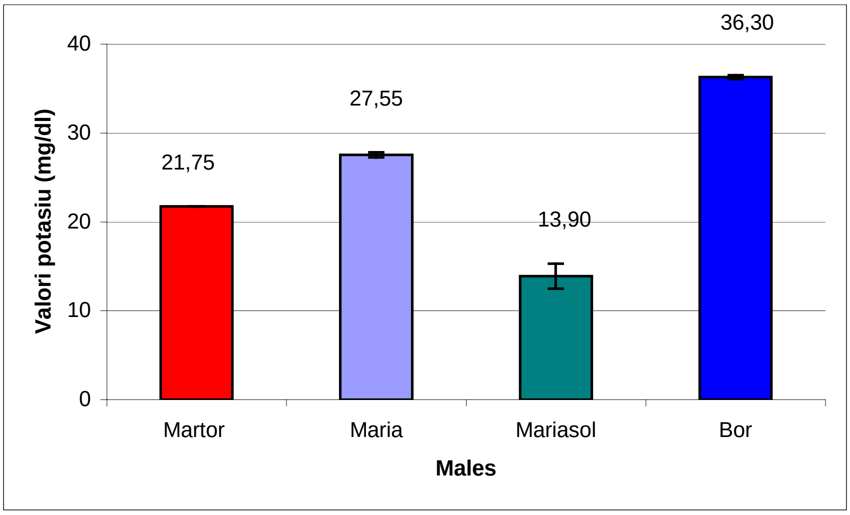


Fig. 18. Variation of sodium in the urine batches of experimental animals

URINARY POTASIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	17,5	30	13,8	36,3	21,3	22,5	13,8	53,8
2	26	25,1	14	36,3	23,3	33,5	30,7	60,5
medie	21,75	27,55	13,9	36,3	22,3	28	22,25	57,15



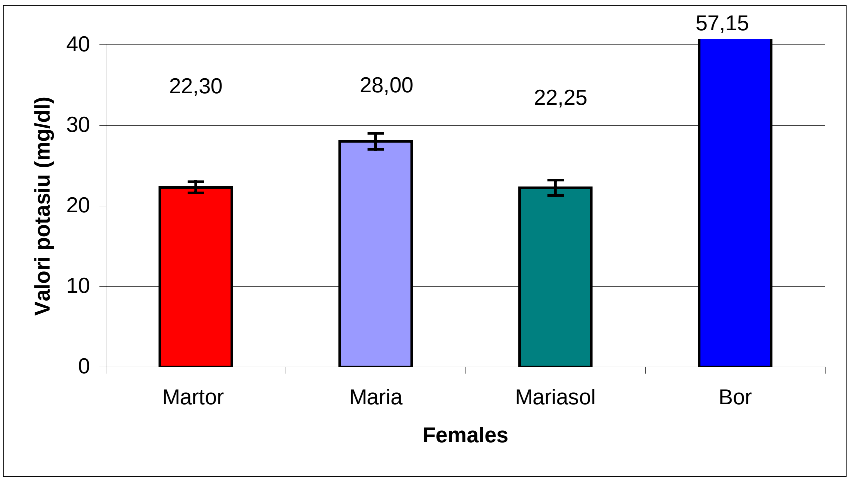
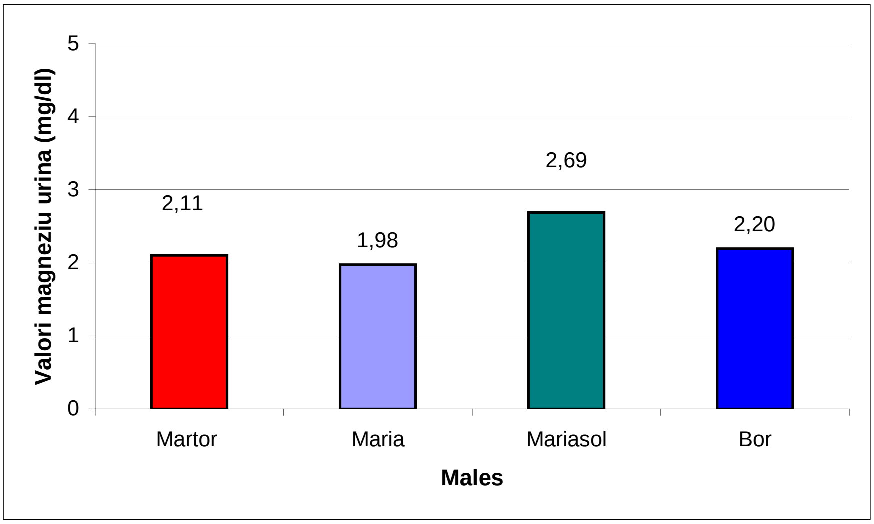


Fig. 19. Variation of urinary potassium experimental animal groups

URINARY MAGNEZIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
1	1,95	1,9	2,64	1,96	1,89	1,91	2,81	1,85
2	2,26	2,05	2,74	2,43	1,94	1,98	2,87	2,49
medie	2,11	1,98	2,69	2,20	1,92	1,95	2,84	2,17



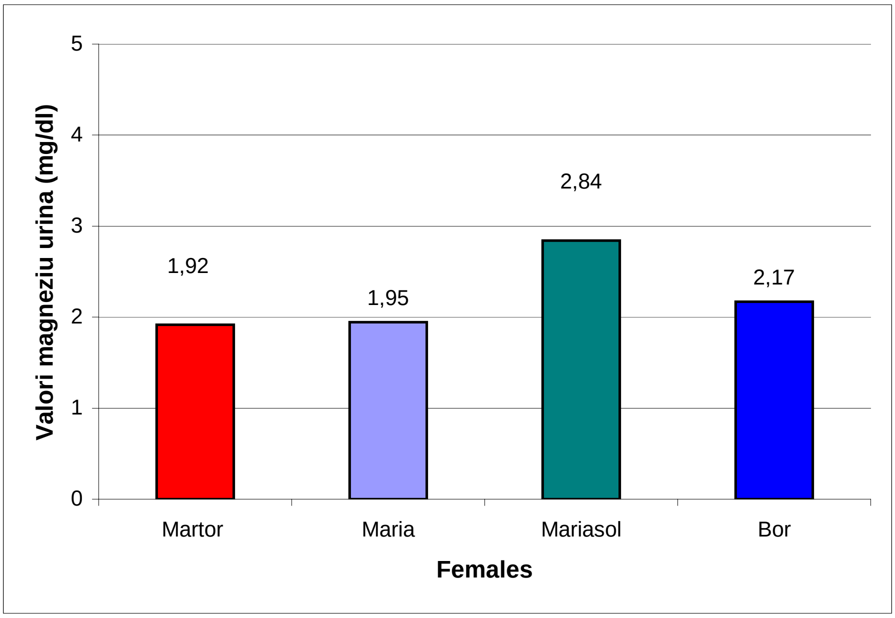
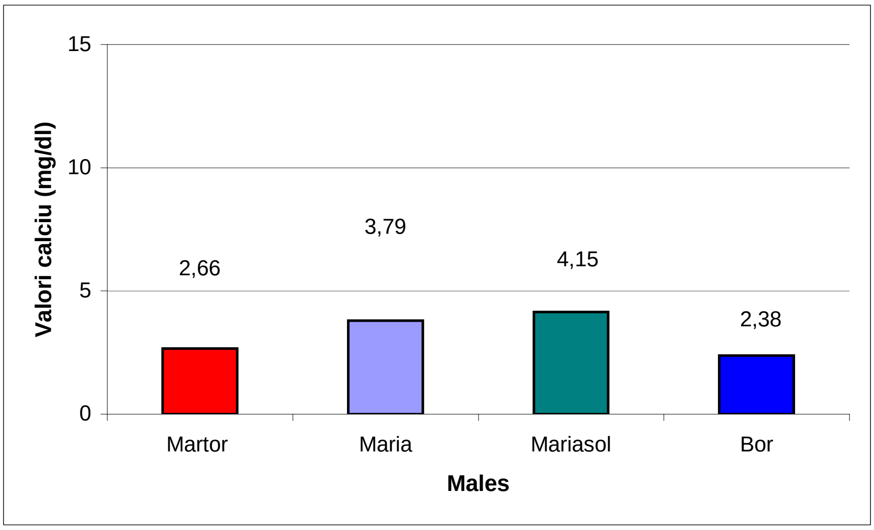


Fig. 20. Variation of magnesium in the urine of experimental animal groups

URINARY CALCIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
	2,66	3,79	4,15	2,38	4,02	0,74	15,75	9,13



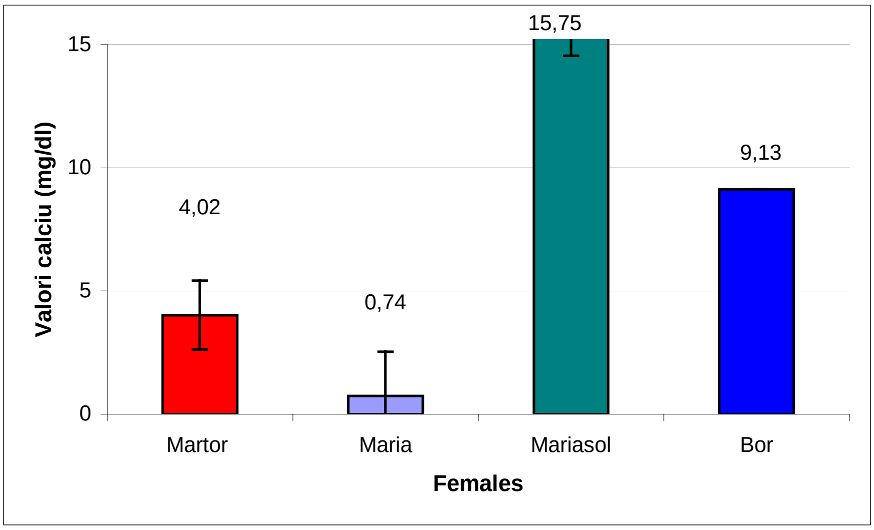
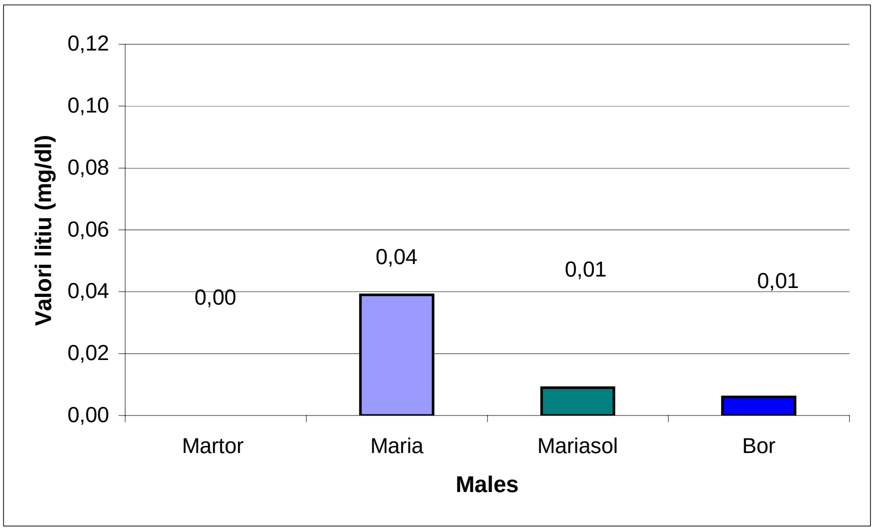


Fig. 21 Variation of calcium in urine lots of experimental animals

LITHIUM	Control males	Water males	Watersol males	Bor males	Control females	Water females	Watersol females	Bor females
	0	0,039	0,009	0,006	0,021	0,078	0,015	0,015



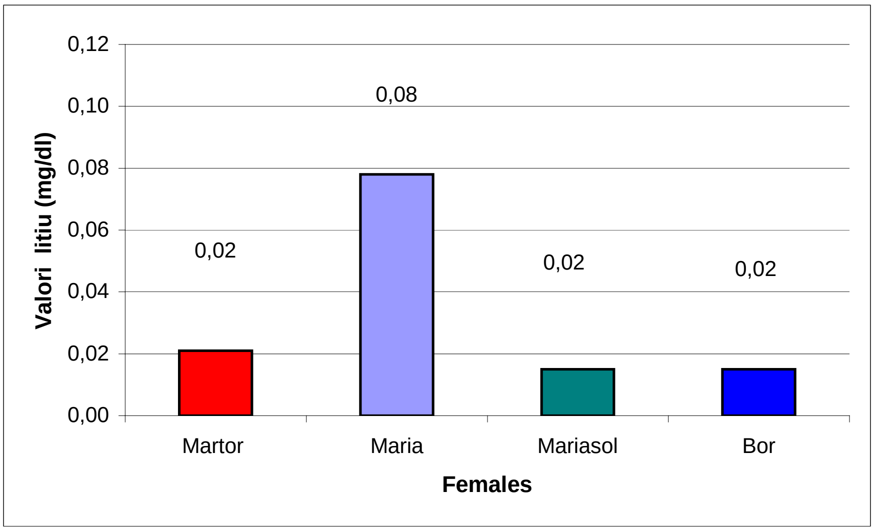


Fig. 22. Variation of lithium in urine batches of experimental animals

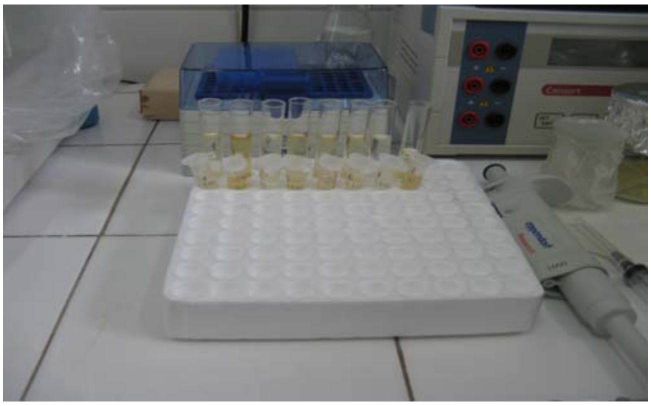


Fig. 23. Analysis of urine samples

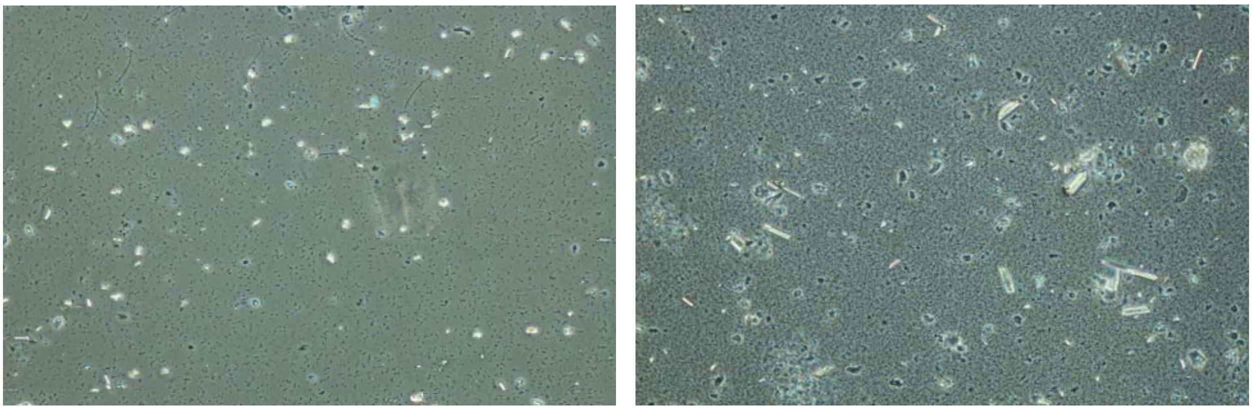


Fig. 24. Urine sample collected from a male / female animal in group Control

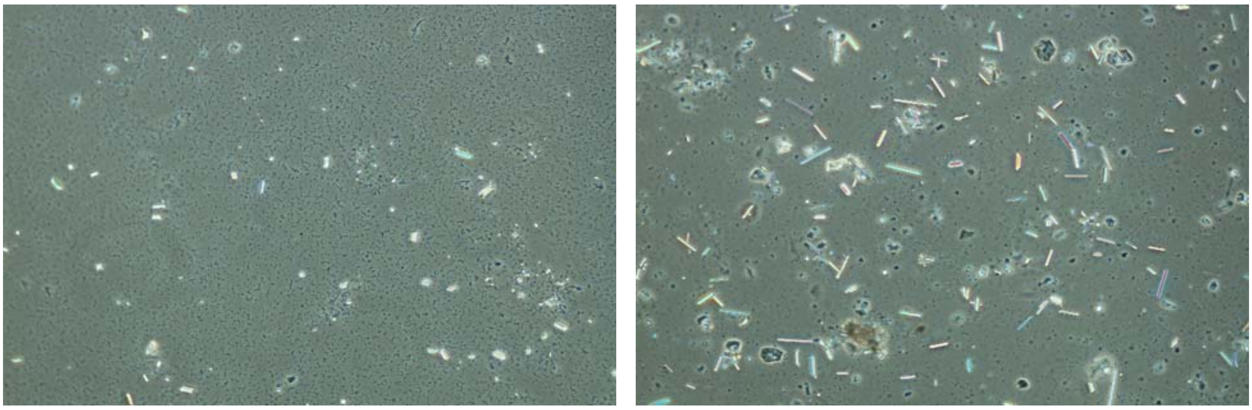


Fig. 25. Urine sample collected from a male / female animal in group Water

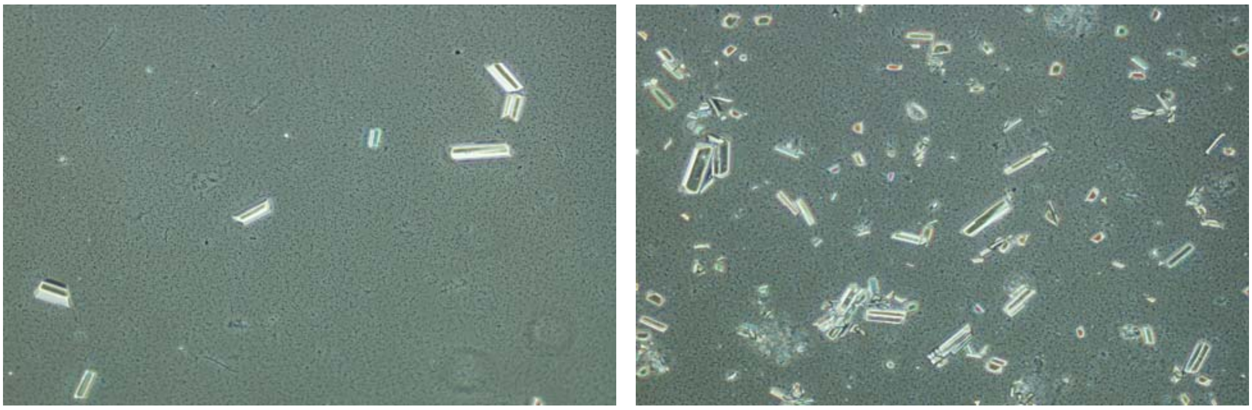


Fig. 26 Urine sample collected from a male / female animal in group Watersol

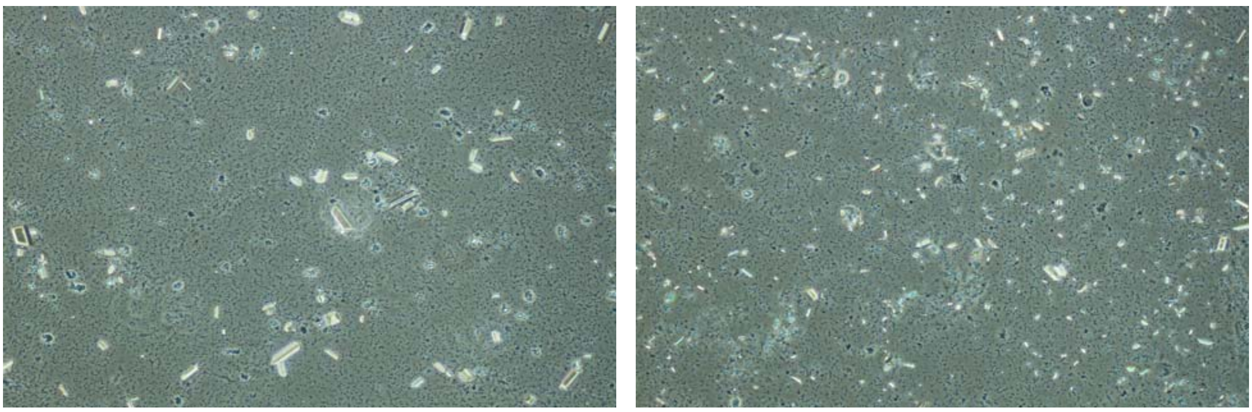


Fig. 27 Urine sample collected from a male / female animal in group Bor