THE CONSEQUENCES OF CHRONIC EXPOSURE TO ALUMINIUM ON SOME MORPHOLOGICAL BIOMARKERS OF REPRODUCTIVE FUNCTION (BODY, GENITAL ORGANS, SEXUAL ACCESSORY GLANDS WEIGHT, SEMINIFEROUS TUBULES DIAMETER) IN MALE RATS

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Summary

The study carried out on 32 male, white Wistar rats divided in three experimental groups (E) which received six month 200, 400 and 1000 ppb aluminium as aluminium sulphate in drinking water and one control group (C) emphasized: significant decrease of body weight comparative to control group (exception, not significant at 200 ppb Al exposure level); significant decrease of genital organs (testis, epididymis) weight comparative to control group (exception, not significant, testis weight in group exposed to 200 ppb Al); significant decrease comparative to control group of sexual accessory glands: seminal vesicles, prostatis (exception, not significant, in the groups exposed to 200 and 400 ppb Al), bulbo-urethral glands (exception, not significant, at 200 ppb Al exposure level); significant decrease of seminiferous tubules diameter comparative to control group (exception, not significant at 200 ppb exposure level); indirect correlation between aluminium exposure level and the studied morphological biomarkers values.

Key words: male rats, genital organs, weight, seminiferous tubules

For a long time period, aluminium was considered as a non toxic element and there are authors that consider aluminium to have even benefic effects (2, 6). Based on a large number of scientific studies, aluminium appears to have negative impact on a series of biologic parameters (1, 3, 8, 14, 15). The negative effects mean to exceed the benefic effects (9, 11), so aluminium could be considered as a trace element with toxic potential risk. The reproductive toxicity was less studied and sometimes the results were contradictory.

Materials and methods

The study was carried out on 32 male white Wistar rats divided in three experimental groups (E) and one control group (C).

The individuals from experimental groups received aluminium sulphate in drinking water as follows:

- C group: tape water (~ 50 ppb) the maximum limits of Romanian standard 1342/1991;

- E_1 group: 200 ppb Al – exceptional limit of the Romanian standard 1342/1991;
- E_2 group: 400 ppb Al;
- E_3 group: 1000 ppb Al, the last two values represents the values found in well drinking water in aluminium industry surrounding areas (7).

Aluminium sulphate was administered six months.

After six month, seven individuals from each group were euthanatized.

Morphological biomarkers, body, genital organs (testis, epididymis) and sexual accessory glands (seminal vesicles, prostate and bulbo-urethral glands) weight were estimated by weighting with technical, respectively analytical balance Shimadzu AY 220.

The seminiferous tubules diameters were evaluated on testis histological section, Mallory stained.

The results were statistically analyzed by ANOVA method and Student test.

Results and discussions

The results are summarized in tables 1 – 7.

Table 1

Mean body weight (g) in male rats chronically exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	418.33±2.79	6.83	17.0
E_1	413.33±11.16 ^{ns}	27.33	17.0
E_2	390.0±3.65 *	8.94	17.0
E_3	350.0±10.95 **	26.83	17.0

E/C: ^{ns} – not significant
* $p<0.05$
** $p<0.01$

Body weight gradually decreased in E groups comparative to C group, not significant ($p>0.05$) in E_1 group (E_1/C: -1.19%) and significantly in E_2 (E_2/C: -6.77%, $p<0.05$) and E_3 groups (E_3/C: -16.33%, $p<0.01$).

An indirect relation was recorded between body weight and exposure level (E_2/E_1: -5.64%, $p>0.05$; E_3/E_1: -15.32%, $p<0.01$; E_3/E_2: -10.25%, $p<0.01$).

The results are similar to those obtained by other authors: Ondreica et al., 1966 quoted by Bast (3), Llobet et al. (8),Yousef et al. (15).

Table 2

Mean testis weight (g) in male rats chronically exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	1.56±0.05	0.13	0.08
E_1	1.49±0.04 ^{ns}	0.1	0.08
E_2	1.34±0.01 **	0.03	0.08
E_3	1.09±0.03 **	0.08	0.08

E /C: ^{ns} – not significant

** p<0.01

In E groups, mean testis weight decreased comparatively to that of group C, not significant (p>0.05) at 200 ppb Al exposure level (E_1/C: -4.48%) and significant (p<0.01) at 400 and 1000 ppb Al exposure levels (E_2/C: -14.1%; E_3/C: -30.12%).

Aluminium exposure level increase has had as consequences the significant (p<0.01) decrease of testis weight (E_2/E_1: -10.06%, E_3/E_1: -26.84%, E_3/E_2: -18.65%).

The results are similar to those of other authors as Seth (12), Bataineh et al. (5), Sahraki et al. (13), Mayyas et al. (10), Llobet et al. (8), Yousef et al. (15), *** (16).

The weight decrease could be explained by body weight decrease (Ondreica et al. 1966, quoted by Bast – 3; 8, 10, 15, 16), decrease of seminiferous tubules diameter and necrosis of seminiferous tubules (17, modifications found in own researches too – unpublished data).

Table 3

Mean epididymis weight (g) in male rats chronicaly exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	0.67±0.01	0.03	0.02
E_1	0.61±0.01 **	0.02	0.02
E_2	0.55±0.01 **	0.01	0.02
E_3	0.5±0.01 **	0.01	0.02

E /C: ** p<0.01

Chronical exposure to aluminium significantly (p<0.01) decreased epididymis weight comparative to C group (E_1/C: -8.95%, E_2/C: -17.91%, E_3/C: -25.37%) and indirectly correlated to aluminium intake level (E_2/E_1: -9.83%, E_3/E_1: -18.03%, E_3/E_2: -9.09%).

Table 4

Mean prostatis weight (g) in male rats chronically exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	1.09±0.04	0.1	0.08
E_1	1.06±0.02 ^{ns}	0.06	0.08
E_2	0.98±0.05 ^{ns}	0.12	0.08
E_3	0.92±0.02 **	0.06	0.08

E /C: ^{ns} – not significant

** p<0.01

In E groups, prostatis weight was lower than in C group, not significant (p>0.05) at 200 and 400 ppb Al (E_1/C: -2.75%, E_2/C: -10.09%) and significant (p<0,01) at 1000 ppb Al exposure level (E_3/C: -15.59%).

An indirect relation, but not strictly proportional, between aluminium exposure level and prostatis was established (E_2/E_1: -7.54%, p>0.05; E_3/E_1: -13.2%, p<0.01; E_3/E_2: -6.12%, p>0.05).

Table 5

Mean seminal vesicles weight (g) in male rats chronically exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	1.85±0.04	0.09	0.07
E_1	1.47±0.05 **	0.11	0.07
E_2	1.16±0.02 **	0.05	0.07
E_3	1.09±0.01 **	0.02	0.07

E /C: ** p<0.01

In E groups, seminal vesicles weight were significantly (p<0.01) lower comparative to C group (E_1/C: -20.54%, E_2/C: -37.29%, E_3/C: -41.08%).

Aluminium exposure level increase determined significant (p<0.05) decrease of seminal vesicles weight (E_2/E_1: -21.08%, E_3/E_1: -25.85%), exception (E_3/E_2: -6.03%, p>0.05).

Table 6

Mean bulbo-urethral glands weight (g) in male rats chronicaly exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	1.24±0.11	0.27	0.12
E_1	1.08±0.04 ^{ns}	0.09	0.12
E_2	0.97±0.02 *	0.06	0.12
E_3	0.86±0.01 **	0.03	0.12

E/C: ^{ns} – not significant

* p<0.05

** p<0.01

Chronic exposure to aluminium had as consequence the decrease of bulbo-urethral glands weight comparative to C group, not significant ($p>0.05$) at 200 ppb Al (E_1/C: -12.9%), significant ($p<0.05$) at 400 ppb (E_2/C: -20.37%) and distinct significant ($p<0.01$) at 1000 ppb Al (E_3/C: -11.34%).

The increase of aluminium exposure level determined the decrease of bulbo-urethral glands weight (E_2/E_1: -10.18%, $p<0.05$; E_3/E_1: -20.37%, $p<0.01$; E_3/E_2: -11.34%, $p<0.01$).

There are few studies concerning the impact of aluminium on sexual organs and accessory glands weight but unanimously sustain the decrease of their weight (4, 8, 10, 13). The decrease of genital organs and sexual accessory glands is the consequence of body weight decrease (Ondreica et al. 1996 quoted by Bast – 3; 8, 10, 15, 16).

Table 7

Seminiferous tubules diameter (μ) in male rats chronically exposed to aluminium

Group	x±Sx	DS	Confidence level 95%
C	340.23±0.39	0.95	3.94
E_1	327.33±2.44 ^{ns}	5.88	3.94
E_2	247.45±1.5 **	3.67	3.94
E_3	224.7±2.48 **	6.06	3.94

E/C: ^{ns} – not significant
** $p<0.01$

In E groups, the diameter of seminiferous tubules were lower than in C group (E_1/C: -3.79%, $p>0.05$; E_2/C: -27.26%, $p<0.01$; E_3/C: -33.95%, $p<0.01$).
An indirect correlation between aluminium intake level and seminiferous tubules diameter was recorded (E_2/E_1: -24.4%, $p<0.01$; E_3/E_1: -31.35%, $p<0.01$; E_3/E_2: -9.13% $p<0.05$).

No data concerning the dynamics of seminiferous tubules diameter were found in studied references.

Conclusions

The study concerning the consequences on some morphological markers of reproductive function in male rats chronically exposed to three different aluminium level emphasized:

- significant decrease of body weight comparative to control group (exception, not significant at 200 ppb Al exposure level);
- significant decrease of genital organs (testis, epididymis) weight comparative to control group (exception, not significant, testis weight in group exposed to 200 ppb Al);

- significant decrease comparative to control group of sexual accessory glands: seminal vesicles, pprostatis (exception, not significant, in the groups exposed to 200 and 400 ppb Al), bulbo-urethral glands (exception, not significant, at 200 ppb Al exposure level);
- significant decrease of seminiferous tubules diameter comparative to control group (exception, not significant, at 200 ppb exposure level);
- indirect correlation between aluminium exposure level and the studied morphological biomarkers values.

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