THE INFLUENCE OF THE SALINE AEROSOLS ON THE STATURO-PONDERAL GROWTH AND ON SOME FUNCTIONAL CHARACTERISTICS OF CHILDREN

Maria Canache[1], Ion Sandu[1], Marin Chirazi[1], Tudor Lupaşcu[2],Ioan-Gabriel Sandu[3,]

Key words: saline aerosols, solions, halochamber, halo-therapy, staturo-ponderal characteristics, functional biometrical characteristics, harmonious physical development.

Abstract: The paper presents the influence of aerosols and respectively that of the in situ resulted solions in dynamic halochambers on the staturo-ponderal growth and on some functional characteristics of children by practicing controlled and systemic sportive games during gym classes, individually and in teams with subjects between 10 and 15 years old. As a reference, children of the same age and with the same schedule were used for the gym classes, but the activities were developed in open air and in gyms, under normal conditions, without aerosols. The study underlined the fact that the saline aerosols and the solions formed in situ in the gym halochamber atmosphere, at a level of over 0.600mg/m³, allowed an improvement of the staturo-ponderal growth more in girls than in boys and visibly superior for both genders in comparison with the youth who trained for three years outdoors or in gyms, in normal conditions, without aerosols.

Introduction

NaCl aerosols, no matter their origin (sea aerosols, salt works, halochambers, saline devices or inhalators) are polydisperse systems whose particles form a pretty large dimensional domain, ranged between the activated simple ions and the giant-sedimentable particles (>500µm). A part of them, starting with the Aitken particles

[1] „Al. I. Cuza" University of Iaşi, Blvd. Carol I, no. 11, 700506, Iaşi, Romania
[2] Chemistry Institute of the Moldavia Science Academy, 3 Academy Str., MD 2028, Chisinau, R. Moldova
[3] „Gheorghe Asachi" Technical University of Iasi, 73 D. Mangeron Street, 700050 Iasi, Romania

(<50μm) up to the sedimentable ones (ranging between 100 and 500μm), under the influence of water vapors and in gaseous atmospheres turn themselves into *solions* - glomerular mutable particles, in a continuous structural reformation, having on their surface a layer of monomolecular water dipoles, oriented with the negative charge towards the exterior and having in their composition one single type of salt [Canache et al., 2012; Sandu et al., 2009, 2010a şi b, 2011].

In the case of the formation of the solions, the same law is respected as in the recrystallisation processes of the salts of the solutions, that is, first, the salt that reaches the first the super saturation recrystallisates, than the second and so on. The first solions that form are those that originate from the labile crystallites of the salts situated on the surface efflorescences.

In the case of a gaseous dispersion of particles formed from the mixture of several salts, the electrostatic forces in the presence of the water vapors will lead to the expansion of these micro crystallites, followed immediately by the structural reformation as solions.

As it is well known, the solions are oligomer structures, with the following formula: $[x(NaCl)_{2n}\cdot y(H_2O)_5]_{(aq)}^{q-}$, where x and y take the corresponding values of some spherical glomerules with diameters between 50 and 500 μm, with n>2 and q- the negative superficial load <1 [Canache et al., 2012; Sandu et al., 2009, 2010a şi b, 2011].

A special characteristic of these particles is represented by the constant in time chemical composition, the shape and their dimension continuously changing under the influence of the microclimatic parameters and of other particles or ions of the atmosphere [Sandu et al., 2003; 2009g, and 2010c].

Depending on the source type and the particles activity, respectively on their lifetime and environment conditions, the solions and the other aerosols of the atmosphere present a dimensional distribution and a sort of regular concentration, as a sequel of the difference between the production speed and that of the turning off or loss, caused by some condensation, coagulation, peptisation, electro neutralization, sedimentation (destabilization), etc. [Sandu et al., 2003; Ştefan, 1998].

The saline aerosols and the solions resulted from natural or artificial sources, depending on the practical applications, must have a minimum amount of lifetime, a certain activity, that is a certain level of the concentration and a well controlled granulometry range [Sandu et al., 2003 and 2009a].

Of the practical implications of those of NaCl, in original form or mixed with those formed of KCl, KI, $CaCl_2$ and MgCl2, in pre-established gravimetric reports, we mention: certain respiratory affliction prophylaxis and therapy, the improvement of the of the psycho-neuromotor parameters and of the cardiorespiratory system, the enhancement of immunity, the purification and the improvement of the quality of atmospheric air, etc. [Sandu, 2010a and b].

Regarding the use of the salt, there is an interesting history, proven by the existence of an *etnoscience,* which generated over the time different applications of the rock-salt (halite) and of the salt aerosols. [Alexianu et al., 1992 and 2007; Cavruc şi Chiricescu, 2006; Weller, Brigand, 2007; Monah et al., 2008; Sandu et al., 2010a].

The researches regarding the practical salt aerosols applications undergone in the recent years substantiated a new direction of study, that of their influences on human performances, paying a special attention to children, elders, people who are working in hard conditions and with elevated level of effort, as well as to sportsmen [Sandu et al., 2009b-g].

In this regard, this paper presents the experimental data concerning the influence of the salt aerosols and of the solions formed in situ in dynamic halochambers on pupils, through gym classes held in an environment with an adequate level of aerosols and solions, which allow the harmonization of the functions and the improvement of the structural and dynamic characteristics of children's bodies.

Experimental Part

Halochamber. The experimental halochamber was set up in a classroom, consolidated, dry, with three thermopane oak and ionized glass windows, with UV filters, with a 150m^3 capacity, with a single entrance through an antechamber (from which one can access the other rooms with destinations that co-assist the halochamber activity). In the enclosure, two devices were installed that were generating dried aero-ions SALIN Plus type, composed of a ventilator and a diaphragm, which contains extruded porous grains of divided rock-salt mixed with KCl, $MgCl_2$, $CaCl_2$ and KI.

The device continuously recycles the air in the room (acclimatized at 60...65% UR and 20...22^oC) by means of a fan, which allows the recirculation of 12...32m^3/h, from a minimum of 6 hours up to 10 hours a day. These devices, take through erosion the salts nanoparticles from the labile crystallites of the surface efflorescences and spread them into the halochamber's atmosphere, where, under the influence of the air humidity, due to the hygroscopicity difference, they are structurally reformulated in shape of some oligomers of salt nanocrystallites and pentahydrol, with the formula: $[x(MeHal_v)_{2n}\cdot y(H_2O)_5]_{(aq)}{}^{q-}$, where Me is Na^+, K^+, Ca^{2+}şi Mg^{2+}, Hal – Cl^- sau I^-, v – the chemical valence of the metallic ion, n- the degree of packing up in crystalline nano-polyhedron ($n > 2$), x and y – the combination report in the glomerule. Glomerules have on the surface, depending on the atmosphere humidity, a monomolecular layer of water dipoles with negative loading to the exterior (q < 1).

In the halochamber, each group of pupils (grouped by ages and grades) worked for one hour, twice a week, for the same groups on Monday and on Thursday, respectively on Tuesday and on Friday for other groups, starting with 10.00 AM up to 18.00 PM, with breaks of minimum one hour to establish the parameters required by the experiment and to restore the solions level.

As a reference, depending on the atmospheric conditions, the activities with the control group took part in the gym (cold and rainy weather) or in open air, on the sport field during the warm periods of the school year.

Establishing the solions level and the microclimatic parameters

Twelve hours before the beginning of the physical training, the devices which produced the solions were switched on in the halochamber. Half an hour before the physical training of the pupils, the environmental and functional characteristics of the halochamber were established. The same characteristics were measured after the end of the training class. In order to measure and monitor the composition of the atmosphere in the halochamber, we used both methods to establish the climatic parameters into an enclosure, as well as a chain of specific methods such as: the conductometric determination of the solions concentration, of the particles quantity and of the lifespan by means of the laser beam optical counter and of the aeroions measuring hopper. [Pascu et al., 2009, Sandu et al., 2010d].

Table 1. Climatic characteristics of the two systems used during the experiment (open air and halochamber)

System	**Parameter**	**Oct 2008**	**Oct 2009**	**Oct 2010**	**Feb. 2011**	**Oct 2011**	**Feb. 2012**
Open air or gym (witness)	T°C	20	20	20	21	20	21
	P,atm	750	740	740	750	750	740
	UR, %	70	60	65	60	60	70
	I, lx	120	116	112	118	120	118
Halochamber	C, mg/m³, solion	0,649	0,667	0,682	0,669	0,705	0,664
	T°C	20	20	20	21	20	21
	P,atm	750	740	740	750	750	740
	UR, %	65	65	65	60	65	60
	I, lx	85	80	80	82	85	82

Because the dynamics of the solions projection in the haloroom is influenced by the environmental conditions, during the measurements, the values of the pumped air were kept constant and the microclimate created in the halochamber was constantly monitored, creating the artificial conditions of temperature and humidity, imposed by the work routine. The measurements were conducted in three areas of the halochamber: in the center of the room, in an upper corner opposed to the door wall, at around 400 mm from the walls and the ceiling and in the middle, near the floor.

The following table presents the climatic characteristics of the two systems used in the experiment (outdoors/gym and in the halochamber). The relative temperature and humidity (RU) were measured with the help of a digitally electric hygro-thermometer, the pressure with a barometer, and the illumination with an electric lux meter.

In the halochamber, both before and at the end of the working out session, the concentration, granulometry, volume and lifespan of the solions in the halochamber were measured by means of the differential conductivity meter and of the particles counter based on an optical laser system (SIBATA GT 321).

Organizing the work sessions and the schedule of the gym classes

The experiments were undergone on young pupils of the V-VIII grades. For each age group, two different groups of pupils (both girls and boys) were selected and each age group was rated in accordance with the subjects' year of birth (1997, 1998, 1999). The reference group for the open air or gym applications, made up of the girls team marked F_{0i}199X, made up of the girl i, with the 199X year of birth and the boys team marked B_{0i}199X, made up of the boy i, with the 199X year of birth, and also the halochamber group, made up of the girls group marked F_{hi}199X, having the girl i, with the 199X year of birth and the boys group marked B_{hi}199X, with the boy i, having 199X year of birth, where i- 1,2,3..7 is the identification number of the pupil in the group, each group being made up of five up to seven pupils.

Both the pupils groups of the halochamber, as well as those taken as reference subjects, of the gym, open air/sports field were ranked on age/grade levels and respecting their school schedule, were attending the sport classes, twice a week for one hour, with at least one day pause between the classes. The gym classes respected their curricula. At the beginning and at the end of the class, for 5-10 minutes, the students executed different respiratory exercises, with deep and slow breaths, as well as long and forced exhales in order to increase the lungs capacity. The organization of the sport routines and the training activities were focused on:

- the improvement and strengthening of the pupils' health (the decrease of the flu frequency and the shortening of the recuperation process, the improvement of the general working capacity, the reduction of the number of the students excused from the gym classes)

- the harmonious physical development of the children (the development of the muscles and of the thorax)
- the increase of the physical capacity (the improvement of the strength and of the resistance of the body)
- the improvement of the body functional capacity by elevating the cardiovascular potential, of the respiratory system (the enhancement of permeability and the improvement of the pleural dynamics) and of the metabolism
- the breathing control, of its amplitude and rhythm through simple techniques in combination with different imagination games in order to eliminate anxiety and to get rid of the psychological pressures.
- the enhancement of the whole scholar performance due to a good psycho-physiological mood, which favors the willingness to learn new things and to accept new ideas in the routine activities.

To achieve all these objectives, exercises were selected – based on the age difference and on the educational curricula - which favored a better harmonization of the biometrical characteristics, both structural and functional, of which we mention:

- walking (different ways of walking), running (different ways of running), jumping (different ways of jumping), exercises for all the body segments (with or without objects, with or without musical background) - the first 20 minutes
- different games (football and basketball for boys and handball and volleyball for girls) - the next 20 minutes

For the functional measurements correlated to the physical effort, the girls did genuflections and the boys pushups, that were counted and timed.

As far as effort was concerned, all these exercises were gradually executed.

The pupils that worked in the halochamber entered in contact with the solions atmosphere both through the skin (the subjects wore in shorts and t-shirts) and through the inhalations.

Biometrical characteristics and their measurements

Within the morpho-structural and functional biometrical examination, in order to determine the level of physical development of the subjects, the following measurements were made:

- the weight, which was calculated by means of the electronic scale and expressed in kilograms and grams
- the height was calculated by means of the staturometer and expressed in centimeters;
- the thorax perimeter, that is the thickness of the thorax, was calculated by means of a metrical ribbon (100 cm) recording two dimensions, with the thorax

perimeter in respiratory pause (the moment between exhale and inhale) and respectively the thorax perimeter in maximal inhalation

- the pulse or the cardiac frequency measured with by means of the HZ-8501 digital tensiometer
- the blood pressure measured by means of the same device
- lungs capacity, established by means of the portable spirometer Peak Flow Meter PFM20, Peak A-I-R, Omron, the maximal air volume being expressed in L/min

Processing the experimental data

Because the study was done using a heterogeneous group of students with a lot of characteristics depending on the exogenous factors (environmental), but also on the endogenous ones (biometric), in order to facilitate the interpretation of the experimental results, we used the tables system, with the evaluation in time of the studied characteristics.

That is why the biometrical data were periodically calculated, that is at 12, 24, 28, 36 and 40 months, to establish the subjects weight and height evolution, while for the calculation of the thorax perimeter growth, the measurements were done at 12, 24 and 40 months.

Taking into account the recorded data, a primary table was created. Afterwards, the mean of the values was calculated for the same period evaluated for each group of pupils, that is the girls group which was recorded as $F_{0m}199X$ and the boys group which was recorded as $B_{0m}199X$, where m represents the arithmetic mean, and X has the value of 7, 8 or 9, depending on the year of birth. Then, the percentage (%) of evolution of the C characteristic was calculated in comparison with the *moment of beginning of the experiment* (C_0), in comparison with the *subsequent measurements*(C_j), the moment of the determination being recorded as *j*, which represents the month of the year of the measurements, using the algorithm:

$$C(\%)F_{0m}199X \text{ or } C(\%)B_{0m}199X = 100 \times (C_j - C_0)/C_0,$$

respectively,

$$C(\%)F_{hm}199X \text{ or } C(\%)B_{hm}199X = 100 \times (C_j - C_0)/C_0;$$

Using these tables, the evolution of each group of students was established and calculated and the influence of the solions on the studied characteristics was established.

Results and discussions

The primary data recorded in the tabular system were followed by their interpretation as well as of their graphical evolution of the morpho-structural characteristics (weight, height, thorax diameter) and of the functional ones (lungs capacity or spyrometry, blood pressure and pulse or heart frequency) in time, for each group of pupils on their age levels. For exemplification, the group of students born in 1997 was chosen.

The weight growth evolution of the group of pupils born in 1997 of the experimental group (of the halochamber) and respectively of the control group used as reference point (the group that practiced in the open air) points out a bigger influence on girls, their weight increasing in comparison with the weight of the boys of the control group.

Table 2. The group of subjects born in 1997, their weight growth (halochamber and open air)

Human Subject	**Weight(kg)**					
	Tile span (Oct. 2008-Feb. 2012), months					
	0	**12**	**24**	**28**	**36**	**40**
	(Oct 2008)	**(Oct 2009)**	**(Oct 2010)**	**(Feb 2011)**	**(Oct 2011)**	**(Feb 2012)**
F_{hm1997}	33,67	38,34	43,33	45,00	48,43	50,64
C (%)	0	13,87	28,69	33,65	43,84	50,40
M_{hm1997}	31,1	34,82	39,68	41,82	45,64	48,06
C (%)	0	11,96	27,59	34,47	46,75	54,53
F_{0m1997}	32,66	35,06	38,48	39,68	42,66	44,68
C (%)	0	7,35	17,82	21,49	30,62	36,8
M_{0m1997}	32,25	35,80	40,58	42,35	46,30	48,85
C (%)	0	11,01	25,83	31,32	43,57	51,47

Taking into account the data of Table 2, one can easily notice a positive evolution of the weight, differentiated by the two sexes. It was noticed that the solions have a higher influence on the girls.

Regarding the height evolution of the pupils (Table 3), it is very interesting that also in this case, the growth is more accentuated in girls, the percentage being of 4,11%, in comparison with that of the boys that is of only 1,65%. For the groups that were practicing in the open air, that growth percentage has almost similar levels, without exceeding 13%, while the halochamber group reaches 17% in the case of the girls and 14% in the case of the boys. It is important to notice that the evolution of the height percentage in the case of the girls of the control group is very similar to that of the boys.

The evolution of the averages of the dimensions of the thorax perimeter recorded in respiratory pause and during the maximal inhale process is presented in table no. 4. If the variation of this characteristic for the pupils born in 1997 is taken into account, we notice that the initial difference of the dimensional averages in the inhale process between the two groups – experimental and witness - is of 2 cm (M_{hm1997} = 83cm, M_{0m1997} = 81cm), and at the end, of 5 cm (M_{hm1997} = 89cm, M_{0m1997} = 84cm).

Table 3. The group of subjects born in 1997, the height growth (halochamber and open air)

Human subject	Height(cm)					
	Period of Time (Oct 2008-Feb.2012), months					
	0	12	24	28	36	40
	(Oct 2008)	(Oct 2009)	(Oct 2010)	(Feb 2011)	(Oct 2011)	(Feb 2012)
F_{hm1997}	145,28	152,14	159,28	161,57	166,71	170,00
C (%)	0	4,72	9,64	11,21	14,75	17,01
M_{hm1997}	141,00	146,60	152,00	153,80	157,80	161,00
3,97	0		7,80	9,07	11,91	14,18
F_{0m1997}	136,40	141,6	146,00	147,60	151,20	154,00
C (%)	0	3,81	7,03	8,21	10,85	12,90
M_{0m1997}	137,00	141,50	146,00	147,67	151,33	154,17
C (%)	0	3,28	6,57	7,79	10,46	12,53

For the girls groups, the initial difference during the inhale process is of 1 cm (F_{hm1997} = 76cm, F_{0m1997} = 75cm), and the final of 4 cm (F_{hm1997} = 82cm, F_{0m1997} = 78cm).

Table 4. The group of the subjects born in 1997, the diameter of the thorax perimeter (halochamber and open air)

Human subject	The diameter of the thorax perimeter (cm)							
	Period of time (Oct 2008-Feb 2012), months							
	Initially		After 12 months		After 24 months		After 40 months	
	Inhale	Exhale	Inhale	Exhale	Inhale	Exhale	Inhale	Exhale
F_{hm1997}	76	71	77	73	80	75	82	78
M_{hm1997}	83	77	85	79	87	81	89	84
F_{0m1997}	75	71	76	72	77	73	78	74
M_{0m1997}	81	75	82	77	83	78	84	79

Regarding the evolution of the maximal volume of exhaled air, presented in table 5, in the case of the pupils born in 1997, a higher growth was recorded in the case of the boys, the percentage difference between the growth recorded in the experimental group and that of the control group is of 11,91% for the boys and of only 5,21% for the girls. Is important to underline that, during the first 12 months, the percentage growths recorded among the girls and boys are very similar, and later, the experimental group of boys recorded an enhanced growth.

Table 5. The group of subjects born in 1997, the evolution of the maximal exhaled volume of air (halochamber and open air)

Human subject	**Maximal exhaled volume of air L/min**			
	Period of Time (Oct 2008-Feb 2012), months			
	Initially	**After 12 months**	**After 24 months**	**After 40 months**
$\mathbf{F_{hm1997}}$	292,86	312,86	332,86	352,86
C (%)	0	6,83	13,66	20,49
$\mathbf{M_{hm1997}}$	322,00	348,00	392,00	424,00
C (%)	0	8,07	21,74	31,68
$\mathbf{F_{0m1997}}$	288,00	304,00	316,00	332,00
C (%)	0	5,56	9,72	15,28
$\mathbf{M_{0m1997}}$	295,00	316,67	335,00	353,33
C (%)	0	7,35	13,56	19,77

In the case of the group of pupils born in 1997, the values of the blood pressure before and after the effort (Table 6) have a different evolution in the case of the systolic blood pressure compared to the diastolic blood pressure. The values of the blood pumped by the heart during the contraction phase (systolic pressure) recorded in the case of the groups which practiced the sport in open air are much higher in the case of the boys than of the girls, the differences between the groups being more obvious for the first 40 months. It is important to notice that the difference between the groups under the solions influence is more accentuated in the first 12 months, and afterwards, the values are more similar, with no noticeable differences, neither between the values recorded during resting periods, nor for those recorded after the effort, like in the case of the groups that worked in open air (this means the body recovers easier after an effort and adapts easier to the effort).

The values of the blood pressure at the moment of reentering the heart (diastolic pressure) present an accentuated decrease after the first 12 months in the case of the boys group which practiced the sport in open air. In the case of the experimental group, the measurements indicate almost the same values before the effort and in the case of the boys, after the effort, the values were lower in comparison with the values for the group of girls. There was no big variation between the values obtained before and after the effort, especially in the case of the girls.

Tab. 6. The group of the subjects born in 1997, the blood pressure values (halochamber and open air)

Human subject	Blood pressure (mmHg)							
	Period of Time (Oct 2008-Feb 2012), months							
	Initially		After 12 months		After 24months		After 40 months	
	TAi	TAf	TAi	TAf	Tai	TAf	TAi	TAf
F_{hm1997}	114-72	120-70	110-72	121-70	115-70	120-72	112-70	113-69
M_{hm1997}	121-73	133-80	117-71	123-69	116-70	121-63	114-68	119-64
F_{0m1997}	106-70	121-69	103-61	111-65	100-66	113-67	102-64	121-63
M_{0m1997}	111-64	130-76	112-63	129-72	115-69	127-66	106-63	122-74

As to the evolution of the heart frequency (Table 7), in the case of the group born in 1997, a decrease of the heart beats/minute recorded after the effort was noticed, the decrease being more accentuated in the case of the boys. At the beginning of the study, the difference between the averages of the pulse recorded before and after the effort for the boys in the experimental group were of 39 beats/minute, and at the end of the experiment, they reached 25 beats/minute.

Table 7. The group of subjects born in 1997, heart beats (halochamber and open air)

Human Subject	Pulse (beats/min)							
	Period of Time (Oct 2008-Feb 2012), months							
	Initially		After 12 months		After 24 months		After 40 months	
	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf
F_{hm1997}	96	121 25	95	109	91	105	86	101 15 10
M_{hm1997}	80	119 39	81	110	80	103	74	99 25 14
F_{0m1997}	86	127 41	91	116	85	103	83	106 23 18
M_{0m1997}	83	113 30	84	106	82	103	79	97 18 12

A more accentuated reduction of the difference between the values recorded during resting time and those after the effort are noticed after the first 24 months. The knot recorded in the measurements done after 24 months could be caused by some health problems that appeared.

Conclusions

According to the experimental data obtained from the two pupil groups, one control group that practiced sports in open air on the sport field or in the gym and the other group practicing the same exercises in the halochamber, differentiated by the two sexes and by ages, encompassing the children born in 1997, one can draw the following conclusions:

- the solions act on the body through the inhaling process and being absorbed through the skin, being a remedy for many diseases; the salt therapy is a complementary and /or alternative method of protection for the respiratory system, but also a way to improve the morpho-structural and functional characteristics of the human body;
- the correct and systematic practicing of the active games in a solion environment substantially increases the pupils resistance to diseases, improves the functionality of the body and some sportive performances;
- the gym classes practiced in schools in a solion environment could help the body improvement, the salt aerosols having a special positive impact on the school chores of the pupils, as well as the performances during the sports competitions;
- the original system of experimental data processing allowed a better distinction of the evolution of the morpho-structural (weight, height, thorax diameter) and functional (lungs capacity, blood pressure and pulse or heart beats) biometrical characteristics for the children, under the solions influence, depending on the age and sex, the researches proving that the solions have a higher influence on the girls;
- the evolution of the height and weight graphics also presents an increased growth in the case of the girls, the percentage difference between the growth recorded in the experimental group and that of the control group being higher for the girls than for the boys;
- the values of the blood pressure before and after the effort have a different evolution in the case of the systolic tension than of the diastolic one; the difference between the groups under the influence of the solions is more accentuated in the first 12 months, and afterwards, the values become more similar, no major differences being recorded neither between the values recorded during the resting times, nor for the values recorded after effort, like in the case of the groups that worked in open air (the body recovers easily after the effort, adapting more easily to the effort).

Acknowledgements

We would like to thank to Ms. Assoc. Prof. Andreea Irina CHIRCULESCU for the English translation of the article.

References

Alexianu, M., Dumitroaia, Gh., Monah, D., (1992), *Exploatarea surselor de apă sărată din Moldova: o abordare etnoarheologică*, Thraco-Dacica, XIII/1-2, p. 159-167

Alexianu M., Weller O., Brigand R.(2007), *Izvoarele de apă sărată din Moldova Subcarpatică. Cercetări etnoarheologice,* Casa Editorială Demiurg, Iaşi;

Canache M., Sandu I., Chirazi M., Lupascu T., Sandu I.G., 2012, Saline aerosols influence on growth staturo-weight children. Present Environment and Sustainable Development, 6(2), 221-234.

Cavruc, V., Chiricescu, A., (2006), *Sarea, timpul si omul*, Ed. Angustia, Sf. Gheorghe;

Monah, D., Dumitroaia, Gh. Garvan, D., 2008, Sarea, de la prezent la trecut, Ed. Constantin Matasă, Piatra Neamţ.

Pascu C., Sandu I., Ciobanu G., Sandu I.G., Vasile V., Ciobanu O., Sandu A.V., Pascu A., (2009), Method and device for determining saline aerosols "in situ", *Patent RO122232 (B1)/*2009-02-27.

Sandu I., Pascu C., Sandu I.G., Ciobanu G., Vasile V., Ciobanu O., (2003), The obtaining and characterization of NaCl nanocrystalline dispersions for saline – type therapeutical media. I. Theoretical aspects, *Revista de Chimie,* **54**, 10, pp. 807-812.

Sandu I., Pascu C., Sandu I.G., Ciobanu G., Sandu A.V., Ciobanu O., (2004a), The obtaining and characterization of NaCl nanocrystalline dispersions for saline – type therapeutical climate. III. The evaluation of the SALIN device reliability, *Revista de Chimie*, 55, 11, 971-978.

Sandu I., Pascu C., Sandu I.G., Ciobanu G., Sandu A.V., Ciobanu O., (2004b), The obtaining and characterization of NaCl nanocrystalline dispersions for saline – type therapeutical environments. II. The in situ analysis of saline room aerosols, *Revista de Chimie*, 55, 10, 791-797.

Sandu, I., Alexianu, M., Curcă, R.-G., Weller, O., Pascu, C., (2009a), Halotherapy: from ethnoscience to scientific explanations. *Environmental Engineering and Management Journal* 8, 6: 1331-1338.

Sandu I., Canache M., Sandu I. G., Sandu A.V., Vasilache V., (2009b), Halocamera artificiala pentru multipli utilizatori, *Patent RO126283-A2/30.05.2011*, *Romanian Patent Application A200900897/05.11.2009.*

Sandu I., Canache M., Lupascu T., Sandu I. G., Sandu A.V., (2009c), Halocamera artificiala pentru multipli utilizatori, *Patent MD4040(B1)/2010. 05.31, R. Moldavia Patent Application A2009005269/09.12.2009.*

Sandu I., Stirbu C., Chirazi M., Stirbu C., Sandu A.V., (2009d), Halocamera artificiala cu multipli utilizatori*, Patent RO126285-A2/30.05.2011, Romanian Patent Application A200900899/2009.05.11*

Sandu I., Stirbu C., Stirbu C., Sandu A.V., (2009e), Microsalina artificiala sau halocamera cu multipli utilizatori, *Patent RO126284-A2/30.05.2011, Romanian Patent Application* A200900898/2009.05.11.

Sandu I., Stirbu C., Lupascu T., Chirazi M., Stirbu C., Sandu A.V., (2009f), Halocamera artificiala cu multipli utilizatori, *Patent MD4089(B1)/2011.01.31, R. Moldavia Patent Application* a2009005257/2009.18.11.

Sandu I., Stirbu C., Lupascu T., Stirbu C., Sand, A.V., (2009g), Microsalina artificiala sau halocamera cu multipli utilizatori, *Patent MD4039(B1)/2010.05.31*, *R. Moldavia Patent Application a2009005252/2009.02.11*.

Sandu I., Chirazi M., Canache M., Sandu G.I., Alexeianu M.T., Sandu V.A., Vasilache V., (2010a), research on NaCl saline aerosols I. Natural and artificial sources and their implications, *Environmental Engineering and Management Journal*, vol. **9**, nr 6, pp. 881-888.

Sandu I., Chirazi M., Canache M., Sandu G.I., Alexeianu M.T., Sandu V.A., Vasilache V., (2010b), Research on NaCl saline aerosols II. New artificial halochamber characteristics, *Environmental Engineering and Management Journal*, vol. **9**, nr 8, pp. 1105-1113.

Sandu I., Poruciuc A., Alexianu, M., Curcă R-G., Weller O., (2010c), Salt and Human Health: Science, Archaeology, Ancient Texts and Traditional Practices of Eastern Romania", *Mankind Quarterly*, **50**, 3-4, pp.225-256.

Sandu I., Chirazi M., (2010d), *Ecologia sistemelor sportive*, Ed. Performantica, Iaşi.

Sandu I., Canache M., Chirazi M., Sandu A.V., Matei P.N., Vasilache V., Matei A., Sandu I. G., (2012), *Artificial Halochamber with Multiple Users and activated procedure*, *Romanian Patent Application A201200255/10.04.2012.*

Ştefan, S., (1998), *Fizica aerosolului atmospheric*, Editura ALL, Bucureşti;

Weller O., Brigand R., Alexianu M. (2007). Cercetări sistematice asupra izvoarelor de apă sărată din Moldova. Bilanţul explorărilor din anii 2004-2007 efectuate în special în judeţul Neamţ, Memoria Antiquitatis, XXIV: 121-190.