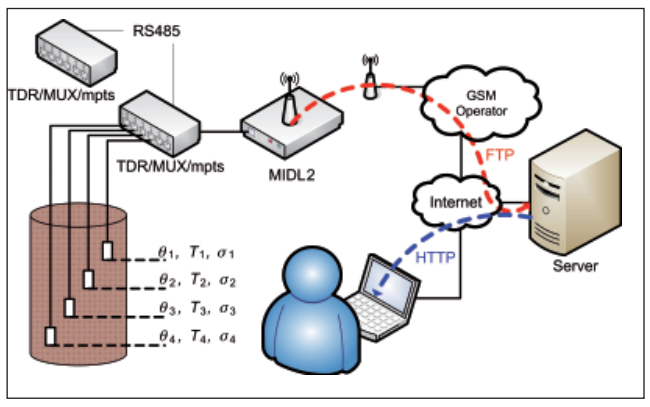
SOIL MOISTURE, TEMPERATURE, AND SALINITY MONITORING SYSTEM

This system is designed to monitor the basic physical parameters of porous materials, i.e. volumetric water content, temperature, and salinity. Special attention is put on soils and the variability of measured properties within different soil layers. The acquired data, supplemented by soil data characteristics for the given location that are relatively stable in time and space plus by plant cover information, enable the water balance of the tested land area to be determined. These data can also offer insight into flood risk, identifying when limit values of soil salinity are exceeded, diagnosing the state of floodbanks, etc. Moreover, automatic ground monitoring of surface soil layers synchronized in time with images taken from satellite radiometers can be used to calibrate those images for the purposes of determining the global water balance on the scale of a single municipality, province, country, or whole continent.

The developed measurement methods, sensors, and equipment can be used in the quality evaluation of porous materials in the food industry, in the storage, transport, production of building materials, etc. The quality of porous materials crucially depends on the moisture, temperature, and salinity.

Fig. 1. Example measurement setup with two eight-channel TDR/MUX/mpts meters, a wireless MIDL-2 data logger, and an Internet server (θ, T, σ stand for soil moisture, temperature, and salinity, respectively)



The elements of this soil moisture, temperature, and salinity monitoring system and the measurement methodology are original developments of the Institute of Agrophysics, the Polish Academy of Sciences, in Lublin. The system consists of: a handheld and stationary eight-channel reflectometric (TDR – Time Domain Reflectometry) meter, an integrated sensor of soil moisture, temperature and salinity, a GPRS modem for wireless communication, and the related software for the meters and Internet server. The reflectometric meters and the integrated probes, formed from parallel waveguides made of stainless steel, measure three physical variables simultaneously and from the same soil volume. The value measured is the speed of travel of an electric pulse along the waveguide rods, which is recalculated into dielectric permittivity and then, based on empirical calibration, into soil moisture. The attenuation of the pulse travelling along the waveguide is the measure of the salinity of the measured object. The sensor has also an electronic temperature sensor built into the sensor body.

The monitoring system is commercially available from the Institute of Agrophysics and it is in use at many research institutions in Poland and all over the world.

The basic technical parameters of monitoring system elements are presented in Fig. 1-3. The ease and high accuracy of soil moisture measurement using these meters make the measurement process more convenient and superior to the standard gravimetric method, and also considerably less expensive in the case of continuous monitoring.

The basic design and manufacturing criteria of the presented system are: (i) achieving an accuracy of soil moisture measurement comparable to that of the standard gravimetric method, (ii) minimizing power consumption (battery supply), (iii) ensuring wireless communication with the system.

The soil moisture, temperature, and salinity monitoring system produced in the Institute of

Agrophysics in Lublin receives about 30 sales inquiries annually. Buyers of the system or system elements are research institutions in Poland and all over the world. The system software developed by the Institute is free of charge.

The system constitutes a scientific measurement tool and it has been described in many research publications. It is also presented at popular-science festivals for the general public, e.g. annually during the Radio BIS Science Picnic in Warsaw and the Lublin Days of Science event.

There are 3 national and 7 international patents which emerged from research and application work based on the described system.

The prices of the system elements are as follows:

- TDR/MUX/mpts – soil moisture, temperature, salinity (electrical conductivity), and soil water matric potential meter: EUR 2200
- MIDL-2 – wireless data logger using GPRS technology: EUR 1550
- FOM/mts/g – handheld meter of soil moisture, temperature, and salinity (electrical conductivity) with GPS option: EUR 2699
- LP/ms – laboratory TDR probe for soil moisture and salinity (electrical conductivity): EUR 99
- LP/p – laboratory probe for soil water matric potential: EUR 239
- LP/t – laboratory probe for soil temperature: EUR 89
- FP/mts – soil moisture, temperature and salinity (electrical conductivity) field probe: EUR 99

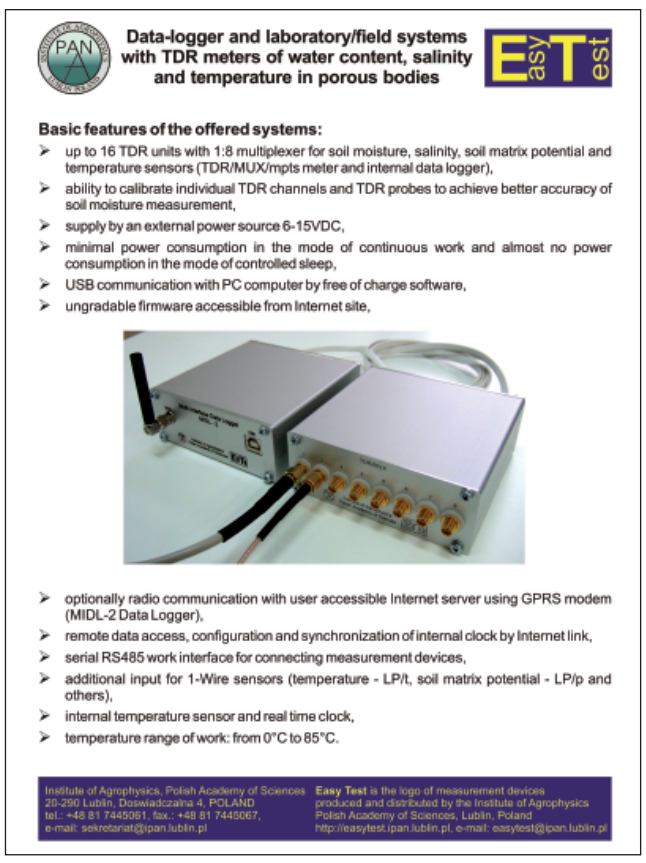


Fig. 2. Basic parameters of soil moisture, temperature, electrical conductivity (salinity), and water matrix potential monitoring system, consisting of an eight-channel TDR/MUX/mpts meter and an Internet data logger MIDL-2

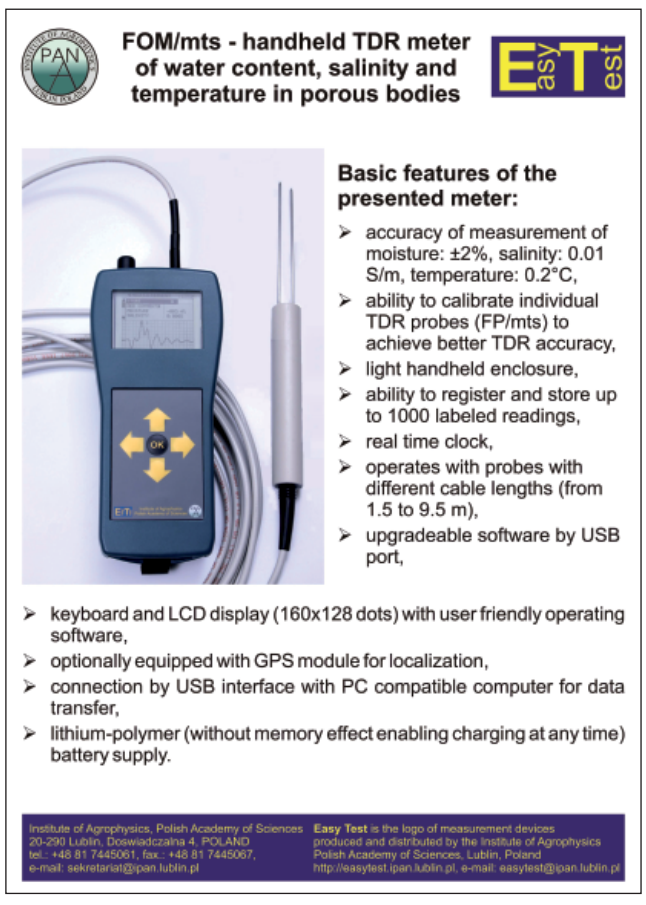


Fig. 3. Basic parameters of a handheld meter of soil moisture, temperature, electrical conductivity (salinity) of the FOM/mts type

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BIODEGRADABLE VEGETABLE OIL FOR CHAIN LUBRICATION IN WOOD-CUTTING CHAINSAWS

This project aimed to solve the problem posed by the release into the environment of noxious petroleum-based lubricating oils used in wood cutting by means of motor chainsaws. The lubricating oil of a chainsaw works in an open system and after performing its lubricating function it is ejected from the machine into the environment. The widespread use of chainsaws in forestry, the tending of green areas, and in construction activities leads hundreds of tons of various lubricating oils to be released into the environment, thus contaminating it due to their long period of degradation.

The objective of this project is to develop a method for producing a biodegradable vegetable lubricating oil based on mustard oil.

Oil obtained from mustard seed, due to its high content of erucic acid, cannot be used as a food product and is therefore considered a waste product in mustard production. The utilization of mustard oil for such a technical application, in the form of the Sinapis oil, offers a way to solve the problem of its utilization in a manner favorable for both the economy and the environment. The Sinapis oil is produced at the Vinegar and Mustard Producing Plant in Parczew from waste mustard oil that is a byproduct in the process of white mustard seed expression for the production of mustard.
Patent No. P-371638.

The Sinapis oil:	
density	896 kg/m^3
kinematic viscosity at 100°C	4.7 mm^2/s
sulfur content	25 mg/kg
water content	460 mg/kg
content of solids	109 mg/kg
flash point	203 °C
cloud point	-7 °C
flow temperature	-16 °C
acid number	2.5 mg KOH/g

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ISOLATED MICROSPORE CULTURES OF SPRING TRITICALE (X *TRITICOSECALE* WITTM.)

Isolated microspore cultures offer a very interesting model of study in which many structurally uniform cells are able to change the direction of programed development and to produce haploid plants through a process known as androgenesis. The haploids produced, after spontaneous or induced genome diploidization, form so called "doubled haploids" (DH) – totally homozygous organisms with a somatic number of chromosomes. DH are widely used in many areas, both as models in basic research as well as in breeding practice.

Utilization of a DH system can save a number of breeding program generations. Moreover, selection is much more effective and reliable as there are no dominance related effects. DH lines are also very advantageous as objects or targets in mutation and transformation studies, gene mapping (especially in the case of polygenic or quantitative traits), and genomics. Today, isolated microspore cultures are incorporated as a method of DH production into breeding programs for many economically important crop species. However, the effectiveness of androgenesis is highly genotype dependent and still not satisfactory in many cases, including in triticale.

This research was carried out on Polish cultivars of spring triticale. Several parameters characterizing cytological, biochemical, and physiological changes taking place in anther tissue during androgenesis induction and then in *in vitro* cultured isolated microspores were analyzed. The course of the process was monitored in cultivars demonstrating various responsiveness toward androgenesis-inducing treatment. Such analysis allows for factors important to the change of microspore development to be identified and characterized and for the barrier of "recalcitrancy" to be overcome. As the result, a method for spring triticale DH production in isolated microspore cultures was established.

Due to its hybrid nature and partial cross-pollination, triticale is characterized by relatively

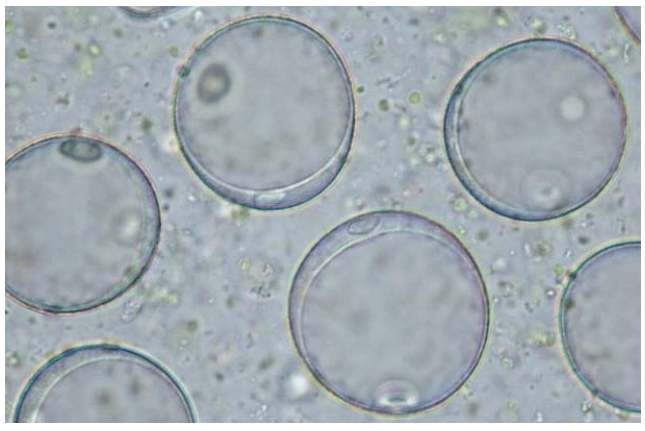

Fig. 1. Isolated microspores of spring triticale *(X Triticosecale* Wittm.) at the late mononucleate stage, optimal for induction of androgenic development (I. Żur)

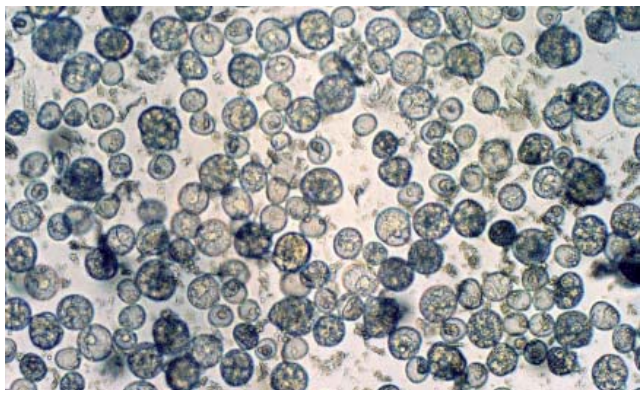

Fig. 2. Multicellular androgenic structures of spring triticale *(X Triticosecale* Wittm.) after 3 weeks of *in vitro* culture (I. Żur)

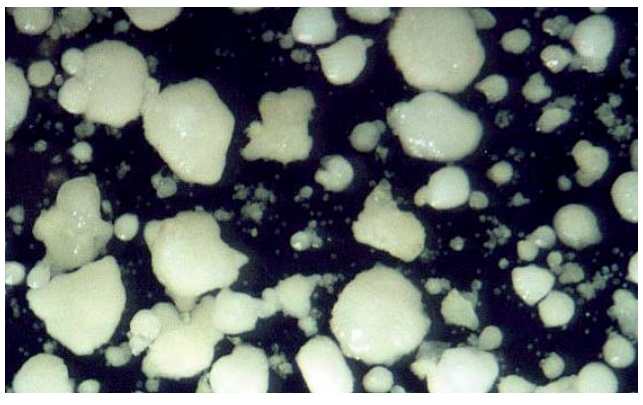

Fig. 3. Androgenic structures of spring triticale *(X Triticosecale* Wittm.) after 6 weeks of *in vitro* culture (I. Żur)

high genomic instability, as result of which decreased yield quality and stability are noted. A quick and effective system for homozygous line production would be greatly appreciated by breeders, allowing them to accelerate breeding programs and quickly react to agricultural market demands. However, no procedure has so far been developed to guarantee effectiveness on a level allowing its incorporation into production on a commercial scale.

This method of isolated microspore culture has proven relatively effective (production of about 6 DH lines per maternal spike) for Polish spring cultivars of triticale. Further work on its optimization is now underway. Moreover, the method enables us to use isolated microspore cultures for quick, univocal, and less expensive selection and to use them as an object of transformation and mutagenesis. It seems that all these features made the method interesting not only to breeders but also to those working in more fundamental research.

The forecast production cost of 1 DH line is about PLN 50. The method has been published and made available to all interested parties.

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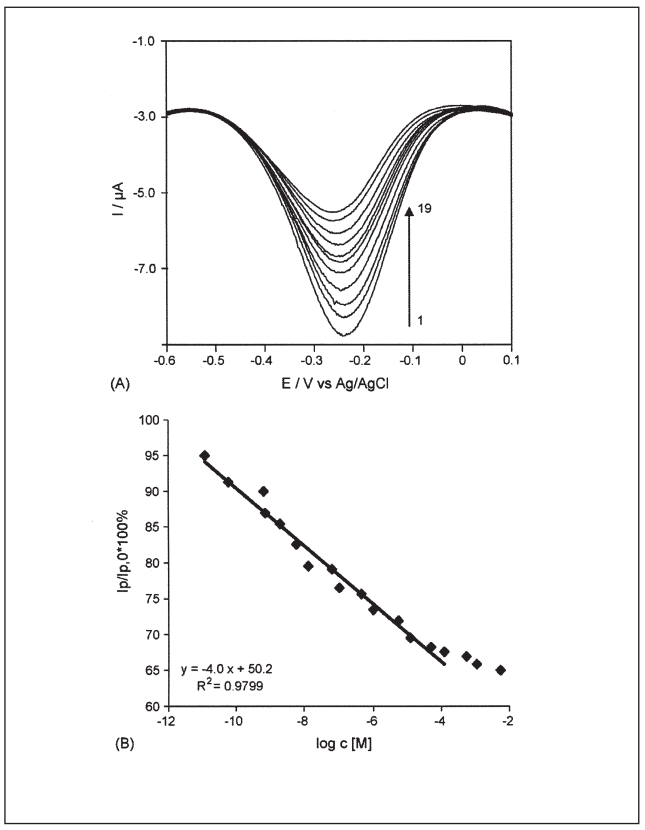
NEW BIOSENSOR FOR ANALYZING ACRYLAMIDE CONTENT IN FOOD PRODUCTS

Recent findings showing that acrylamide is formed in heat-treated foods rich in asparagine and reducing sugars such as glucose have accelerated the need to develop new analytical methods for identifying this potential human carcinogen. Acrylamide forms adducts with hemoglobin (Hb) as a result of the reaction with the -NH2 group of N-terminal valine of Hb. This interaction has been harnessed as the basis for a new voltammetric biosensor for detecting acrylamide. This biosensor was constructed using a carbon-paste electrode modified with hemoglobin (Hb), which contains four prosthetic groups of heme – Fe(III). Such an electrode displays a reversible reduction/oxidation process of Hb-Fe(III)/Hb-Fe(II). The interaction between Hb and acrylamide was observed through the decrease of the peak current of Hb-Fe(III) reduction (see graph A).

The proposed biosensor has proven effective with regard to the following parameters: very good sensitivity towards acrylamide (detection limit of 1.2×10^{-10} M), very good selectivity (the matrix, water extract taken from potato crisps, has no influence on the electrochemical signal generated in the presence of acrylamide in solution), and a very simple procedure of sample preparation. Carbon-paste electrodes modified with hemoglobin might therefore be recommended for the direct electrochemical determination of acrylamide in food samples.

Generally, analysis of acrylamide in food products focuses primarily on chromatographic methods (such as LC-MS/MS, GC-MS, and HPLC-MS), all of which are expensive and time-consuming. In some of them, the derivatization of acrylamide by bromination is involved, potentially acting as a source of artifacts. Most of these techniques are complex, which may cause discrepancies between determinations. These disadvantages of widely used analytical methods and, at the same time, growing demand for rapid and precise determination of acrylamide in hundreds of food samples, has stimulated us to develop alternative methods suitable for screening of this neurotoxic and carcinogen compound.

Electrode with carbon paste modified with hemoglobin



(A) The response of carbon paste electrodes modified with Hb-DDAB liposomes towards acrylamide in the presence of potato crisp water extract. Concentrations of acrylamide: (1) 0 M, (2) 1.3×10^{-11} M, (3) 6.3×10^{-11} M, (4) 6.3×10^{-10} M, (5) 6.9×10^{-10} M, (6) 2.0×10^{-9} M, (7) 6.0×10^{-9} M, (8) 1.3×10^{-9} M, (9) 6.2×10^{-8} M, (10) 4.7×10^{-7} M, (11) 1.1×10^{-6} M, (12) 5.8×10^{-6} M, (13) 1.2×10^{-5} M, (14) 4.8×10^{-5} M, (15) 1.2×10^{-4} M, (16) 5.3×10^{-4} M, (17) 1.1×10^{-3} M, and (18) 5.6×10^{-3} M. Measuring conditions – electrolyte composition: 0.05 MNaBr, acetate buffer (0.2 M, pH 4.8), step potential of 0.0024 V, square-wave frequency 100 Hz, square-wave amplitude 0.025 V.

(B) The ratio of OSWV peak current in the presence of a given concentration of acrylamide (I_p) to that in the absence of analytes ($I_{p,0}$) as a function of concentration of acrylamide in potato crisp water extract. The currents were measured at the peak potential in OSWV curves in the solution with no analyte ($E_{p,0} = -242$ mV); ($n = 3$; 3.1 < S.D. < 9.1).

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SALSOLINOL, A NEUROMODULATOR IN THE HYPOTHALAMIC-PITUITARY AXIS IN SHEEP DURING LACTATION

Salsolinol (1-methyl-6,7-dihydroxy-1,2,3,4-tetrahudroisoquinoline) is a dopamine-derived endogenously synthesized compound within the central nervous system (CNS) of humans and animals. It is considered to be involved in the progression of disease characterized by the dysfunction of dopaminergic neurons, as in the case of Parkinson's disease. More recent data suggest that salsolinol may also have the neuromodulatory property within the hypothalamic-pituitary axis and selectively stimulate prolactin release from the anterior pituitary.

The following hypotheses were tested in our studies: salsolinol was present in the mediobasal hypothalamus (MBH) of lactating sheep and its extracellular concentration in the MBH increased in response to suckling, similarly to the plasma prolactin concentration; exogenous salsolinol, infused into the third brain ventricle of lactating sheep, stimulates the release of prolactin from the pituitary to the peripheral circulation.

Stainless steel guide canullae were implanted in sheep under stereotaxic control into the MBH (n=6) or into the third ventricle (n=10) through a drill hole in the skull during the second month of pregnancy and two experiments were performed during the fifth week of lactation (28-32 day).

1) *In vivo* perfusion of the MBH with Ringer-Locke solution by the push-pull method. The flow rate was 7 μl/min and the volume of one perfusate collected during 30-min period was about 250 μl. The collecting period in every ewe consisted of control non-suckling period, from 10:00 a.m. to 12:30 p.m. (five perfusates) and suckling period, from 12:30 p.m. to 15:00 p.m. (next five perfusates).

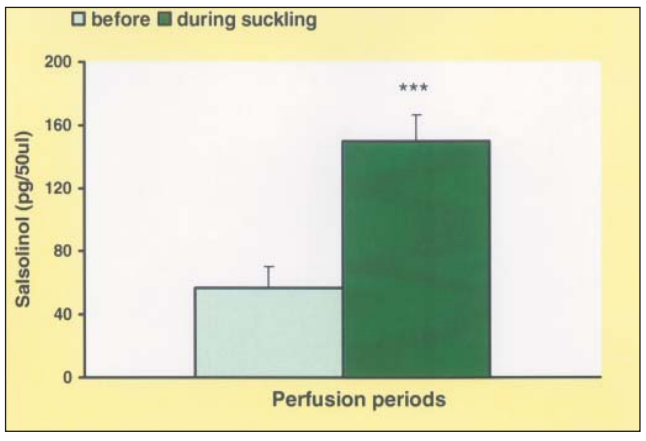

Fig. 1. Mean perfusate salsolinol concentration in suckling sheep. *** P<0.001

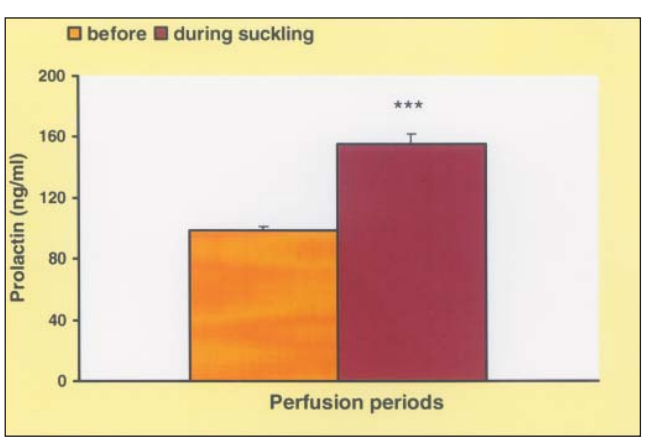

Fig. 2. Mean plasma prolactin concentration in suckling sheep. *** P<0.001

2) Pulsatile infusions of exogenous salsolinol (5 x 1 μg/20 μl/10 min, n=5) or vehicle (control, n=5) into the third ventricle were performed from 12:30 p.m. to 15:00 p.m., corresponding to the suckling period in perfused sheep. The preinfusion period was from 10:00 a.m. to 12:30 p.m. and during infusion lamb(s) had restrained access to the mother's udder. In both experiments, plasma samples were collected every 10 minutes, through a catheter inserted into the jugular vein. The perfusate concentration of salsolinol was assayed

by high performance liquid chromatography with electrochemical detection and plasma concentration of prolactin by radioimmunoassay.

The presence of salsolinol, but not dopamine, was detected in the perfusates collected from the MBH of lactating sheep. Perfusate salsolinol concentrations during the non-suckling period was 56.82 ± 13.78 pg/50 µl (mean ± SEM) and increased significantly during suckling period to 150.08 ± 16.85 pg/50 µl (P<0.001, Fig. 1). Plasma prolactin concentrations noted during these perfusion periods were 98.60 ± 2.87 and 155.66 ± 5.96 ng/ml (P<0.001, Fig. 2), respectively.

Exogenous salsolinol infused into the third ventricle evoked a significant increase in plasma prolactin concentration, 137.97 ± 11.47 ng/ml, as compared with the concentration noted during the preinfusion period, 104.04 ± 4.98 ng/ml (P<0.01) and with that during control infusion, 77.06 ± 5.76 ng/ml (P<0.001, Fig. 3).

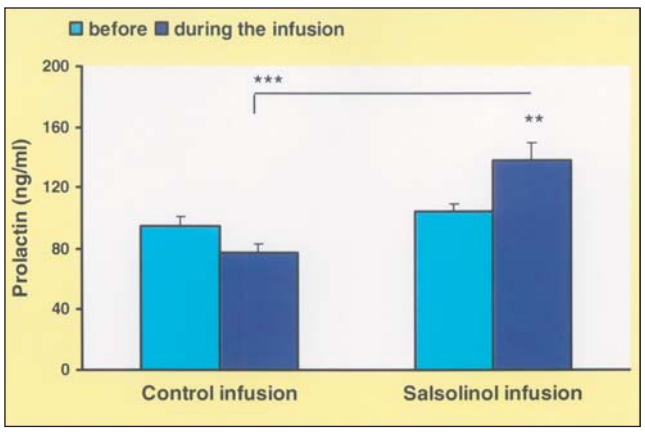

Fig. 3. Mean plasma prolactin concentrations in control and salsolinol-infused lactating sheep. ** P<0.01; *** P<0.001

This study provides the first data on the presence of salsolinol in the hypothalamus of lactating sheep. An increase in the extracellular concentration of this compound within the mother's MBH occurred in response to suckling and it was closely related to an increase in plasma concentration of prolactin. Moreover, exogenous salsolinol infused directly into the CNS of lactating sheep clearly stimulated the release of prolactin from the pituitary gland. Our data support the role of salsolinol as a neurotransmitter involved in the regulatory process of prolactin secretion during lactation.

The use of sheep as a model in research on the action of salsolinol in the central nervous system (CNS) opens up possibilities for more precise studies on the relationships between this compound and neurons producing other neurotransmitters and/or regulatory peptides. Of special importance may be the etiology of Parkinson's disease and other neuronal disturbances characterized by an altered activity of the dopaminergic system. Not less important is the recognition of the mechanism of hyperprolactinemia, which sometimes occurs around the suckling period. Overproduction of salsolinol in the CNS may probably be implicated in maintaining the state of hyperprolactinemia. Recognition of the axes of salsolinol synthesis in the CNS and next the possibilities of its regulation may help to eliminate numerous unfavorable and unfortunate events in human life.

[1] Misztal T., Górski K., Tomaszewska-Zaremba D., Molik E., Romanowicz K. (2008). Identifications of salsolinol in the mediobasal hypothalamus of lactating ewes and its relation to suckling-induced prolactin and GH release. *Journal of Endocrinology*, 198, 83-89.

[2] Misztal T., Górski K., Tomaszewska-Zaremba D., Molik E., Romanowicz K. Salsolinol as a hypothalamic neurotransmitter stimulating prolactin release during suckling in ewes. 16th International Congress on Animal Reproduction, Budapest, Hungary, 13-17 July 2008. Abstract P355.

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