ANIMAL NUTRITION

in the company of physiology

The Kielanowski Institute of
Animal Physiology and Nutrition
Polish Academy of Sciences

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A Polish agriculture transformation

Following Poland's accession in 2004, their agriculture sector has seen a transformation in terms of growth, but the desire for improvements continue. Adjacent Government outlines the latest developments...

Poland's accession into the European Union in 2004 has enabled the country to transform its agriculture sector. From the initial concerns from farmers fearing they would drown in a sea of subsidised produce, what has actually happened is an increased spend, with payments from the Polish state nearly tripling since accession. One expert, Jerzy Wilkin, an economics professor at Warsaw University even commented that "This is a golden age of Polish farming," adding that "Never before has such large amounts of money flowed into agriculture."

The process of accession gave farmers access to funds from the Common Agricultural Policy, and in particular to direct payments that came with a threshold set at just one hectare.

The dairy sector, for instance has flourished, partly fuelled by a need to comply with costly regulations governing any modernisation plans. This, in turn, has attracted international agri-food companies to Poland, and helped prompt an export boom.

However, Poland is currently in a battle with the EU following a French accord with Russia to lift its ban on live pig and pork imports, saying they broke the "principle of European solidarity". Pressure is mounting on the European Union to consider tougher sanctions on Russia following the continued crises in Ukraine. France is expected to see the ban on live pigs, offal and fat, that was imposed by Moscow a year ago, to be lifted for France.

Poland's Agriculture Minister Marek Sawicki has said that both the EU health commissioner, Vytenis Andriukaitis, and the farm commissioner, Phil Hogan, said they didn't give a green light for bilateral deals with Russia. Britain, Germany, and the Baltic states are backing the Polish stance, demanding that the EU retains its solidarity.

Aside from the current political fighting, Minister Sawicki continues to fight for the rights (and payments) for Polish agriculture. Looking ahead to the financial perspective to 2020, funds are likely to be similar to what has been spent so far. The Rural Areas Development Programme will have a consistent system of payments, which has been focussed on active farmers, so that the highest number of family-owned farms will be able to become permanently bound with the market and at the same time, gain financial stability. This should allow for the further development of Polish, and European agriculture. The demand for food will grow, as will high quality food. With around 30% of Polish agricultural production exported, Poland will still be looking for new target markets – the Russian embargo introduced in 2014 confirming this approach as a necessity.

Adjacent Government
editorial@adjacentgovernment.co.uk
www.adjacentgovernment.co.uk

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Administration and Laboratory building

The Kielanowski Institute of Animal Physiology and Nutrition (KIAP&N) of the Polish Academy of Sciences in Jablonna (Poland) is one of the leading research centres whose mission is to conduct fundamental and applied research in the fields of farm animal nutrition and physiology.

The studies related to animal nutrition encompass the metabolism and utilisation of nutrients and biologically active substances from feeds, the improvement of the health-promoting qualities of poultry, pork, and lamb meat, as well as the symbiotic microorganisms colonising various sections of the digestive tract.

The main research areas of animal physiology are related to the central mechanisms regulating growth, maturation, and reproduction of animals as well as the development of the structure and function of the digestive tract.

Studies are carried out by 35 researchers supported by technical staff, working in five departments and two interdepartmental laboratories: Department of Monogastric Nutrition, Department of Ruminant Physiology of Nutrition, Department of Protein and Energy Metabolism, Department of Endocrinology and Department of Neuroendocrinology, as well as in the Laboratory of Chemistry and Laboratory of Molecular Biology.

Animal houses

To produce healthy pork and poultry

The Department of Monogastric Nutrition specialises in conducting research on the physiology of nutrition of pigs and poultry (broiler chickens in particular). One line of research focuses on improving feeding recommendations, while others investigate the influence of nutritional factors on the development of the gastrointestinal tract, nutrient digestibility and metabolism.

Scanning carcass composition

Broiler chickens

For pigs, particularly for weaned piglets, changes in the composition, form, and quality of feedstuffs may cause health problems and inhibit their growth. Morphological and functional changes in the digestive tract can be modulated by bioactive compounds present in feedstuffs or added to the diet. In addition to changes in morphology, a very important issue is microbial activity, mostly in the large intestine. Species composition, as well as the number of microbes, influences not only fermentation of nutrients reaching the caecum and colon, but also creates the environment for the digesta. Recent investigations have concerned the influence of various types of protein, differing in their digestibility in the small intestine, fed with indigestible carbohydrates (resistant starch, pectin, cellulose) on fermentation processes in the large intestine, and their role in digestive tract development. It has been found that the effect of protein type on microbial activity in the large intestine is modified by the type of carbohydrate in the diet and that this should be taken into account during formulation of diets for pigs. In other research connected with digestive tract development and microbial activity, the possibility of using inulin-type fructans from chicory roots or Jerusalem artichoke as feed additives was examined. In piglets and chickens, some beneficial results that depended on the degree of fructan polymerisation were observed. Dietary supplementation with inulin and a probiotic preparation also had a beneficial effect.

Broiler chickens

One important topic is the improvement of the functional properties of broiler chicken meat. Excess saturated fatty acids and a high proportion of n-6 to n-3 unsaturated fatty acids in human diets can promote many diseases of civilisation, such as cardiovascular disease, obesity, cancer, and diabetes. Numerous research has been conducted to increase the deposition of polyunsaturated fatty acids, particularly from the n-3 family, in pigs and poultry. This can be achieved by using various sources of unsaturated fatty acids, including fish oil, linseed oil, and rapeseed oil in different combinations and fed them at different times before slaughter. In parallel, a supplementation with natural antioxidants is necessary. It was found that rapeseed and fish oil can be used for the modification of fatty acid composition in broiler meat. The meat and fat of broilers fed diets with rapeseed, linseed, and fish oil can be considered high in n-3 polyunsaturated fatty acids, but the dietary level of fish oil should not exceed 1% to avoid deterioration of the sensory characteristics of animal products. Increased levels of unsaturated fatty acids in the diet, and finally in the meat and fat of broiler products,

Piggery with laboratories

HPLC analysis devices

requires supplementation with vitamin E and selenium to counteract oxidative stress and to increase the stability of these acids during frozen storage.

Protein sources

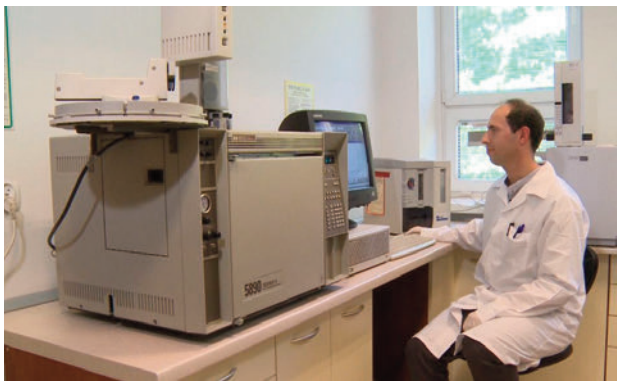
Since the use of feeds derived from the genetically modified (GM) plants is strongly criticised in Poland, we investigated the possibility of adverse effects of their use in broiler feed mixtures. The use of GM soybean meal and maize in broiler diets did not affect performance or immunological status, intestinal morphology, epithelial cell turnover rate in the small intestine, intestinal ecosystem composition and activity. However, Clostridia in birds fed GM soybean meal were more resistant to kanamycin compared with conventional soybean meal.

Also the effects of using locally produced plant protein sources as an alternative to GM soybean meal were evaluated. Among others, different varieties of pea and lupine seeds, raw or processed, as well as rapeseed products were used in pig and broiler diets supplemented with enzymes or probiotics. It was found that partial replacement of soybean meal by protein from different legumes or rapeseed products in diets for growing pigs and broiler chickens is possible without adverse effect on feed utilisation and digestive tract physiology. The total elimination of soybean meal from broiler diets is possible only with a complementary dose of potato protein concentrate.

Health-promoting compounds in ruminants

Recent studies show that omega-3 polyunsaturated fatty acids (Ω-3 PUFA) reduce inflammation and can help lower the risk of chronic diseases such as heart disease, arthritis, and cancer. Ω-3 PUFA are highly concentrated in the brain and appear to be important for cognitive (brain memory and performance) and behavioral function. Infants who do not get enough Ω-3 PUFA from their mothers during pregnancy are at risk for developing vision and nerve problems. Symptoms of Ω-3 PUFA deficiency include fatigue, poor memory, dry skin, heart problems, mood swings or depression, and poor circulation. On the other hand, most Ω-6 PUFA tend to promote inflammation. Unfortunately, the typical western diet tends to contain a high level of saturated fatty acids as well as 14–25 times more Ω-6 PUFA than Ω-3 PUFA, which many nutritionally oriented physicians consider to be much too high on the Ω-6 side.

The current studies are focused on the metabolism of amino acids (especially essential amino acids), Ω-3 PUFA, and CLA isomers in



Chromatographic analysis

Piglets in the lab

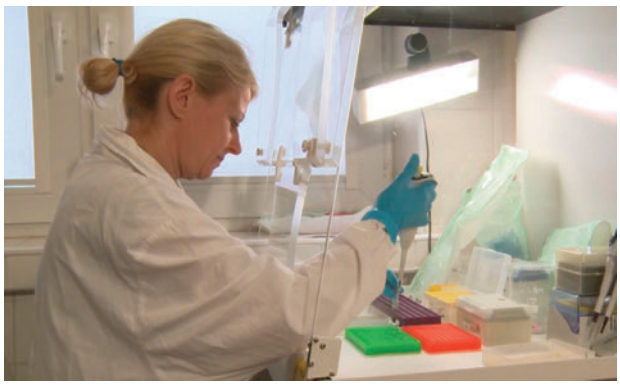
both the ruminal fluid and livestock carcasses, using *in vivo* and *in vitro* techniques. It was shown that dietary selenium (Se), plant and fish oils positively modify the profile of health-promoting fatty acids, as well as reduce the level of harmful oxidized species in the edible parts of carcasses of farm animals. Moreover, the optimal health-promoting levels of lycopene and different chemical forms of Se added to the diets of farm animals have been established; this is important information for nutritionists carrying out investigations to improve the nutritive value of food for human health. The studies on laboratory animals also revealed that dietary CLA isomers reduced the content of fatty acids and stimulated the accumulation of amino acids (and thus proteins), especially essential amino acids, in the muscles of monogastric animals. Finding that selenate and some selected CLA isomers fed to monogastric animals considerably increase the level of Se, Zn, CLA isomers, non-CLA fatty acids containing double bonds (anabolites of dietary and endogenic CLA isomers) and other PUFA in the muscles of laboratory animals is valuable information for physiologists.

Gastrointestinal tract development in pig's neonates

The development of the mammalian gastrointestinal tract is a complex process that starts prenatally and ends in the early postnatal period. It involves tissue growth combined with cells differentiation and the development of digestive functions, which leads to irreversible gut maturation. Any disruption in this process may generate serious consequences for the neonate, which often causes high mortality in suckling piglets.

Studies on the maturation and functioning of the gastrointestinal tract in newborn piglets are part of research conducted in the Department of Endocrinology. The investigations concern bioactive colostrum and milk compounds, i.e. hormones, growth factors and cytokines, which may affect gut maturation as well as motor functions of the small intestines on both *in vitro* and *in vivo* models. The researchers established the unique animal model that enables nursing and rearing of neonatal piglets in controlled laboratory conditions. Studies in newborn pigs have an impact not only on progress in these animals breeding, but to a large extent can be transferred to the man. Especially the early-born piglets may be regarded as the only model for premature babies.

Current research focuses on nutritional programming, a phenomenon based on epidemiological and animal model studies



DNA isolation

Hamilton pipetting robot

which have shown that development and growth during the early life period is markedly influenced by maternal health and diet composition. It is suggested that maternal diet influences the metabolic status and plays a crucial role in the development of metabolic functions in offspring and their risk of metabolic diseases in adulthood.

Central regulatory mechanisms

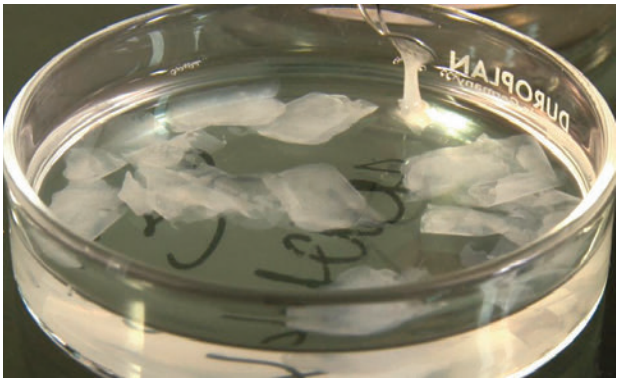
A number of experimental techniques have been developed in the Department of Neuroendocrinology that make it possible to conduct experiments *in vivo* at the level of the central nervous system (CNS). The stereotactic equipment conforming to the atlases of the rat and sheep brains enables precise implantation of cannulas into the brain ventricles or chosen hypothalamic nuclei. Currently conducted studies address a wide range of topics especially related to different hypothalamic-pituitary axes.

One of the investigations is focusing on the relationship between the functional state of GnRH neurons in the hypothalamus and the expression of genes in gonadotrophs in the anterior lobe of the pituitary gland. Analysis is based on changes in the activity of intracellular systems responsible for regulating the expression of genes determining the activity of promoters of gonadotropin subunits and of the gonadotrope GnRH receptor gene.

A further area of study deals with the characteristics of the Cu-GnRH complex activity. This unique analogue of gonadoliberin is characterised by specific parameters of intracellular activity, including increased resistance to enzymatic degradation, as well as the ability to activate different signaling pathways in pituitary gonadotropes. Due to potential use of the Cu-GnRH complex in treatment of GnRH-gonadotropin dysfunctions, it is particularly important to conduct a comprehensive study of this molecule's activity in gonadotropes.

Other research addresses the effect of immunological stress caused by bacterial and viral infections on the function of the GnRH/LH gonadotropic axis. Consequences of stress of this type include disorders of the ovulatory cycle, or even complete infertility. The focus of these studies is elucidation of the interactions between the reproductive and immune systems, which are specific for each level of the hypothalamus-pituitary-gonadal axis. The results of these studies suggest that the hypothalamus – a structure integrating the functioning of the nervous, hormonal and immune system – plays a key role in the inhibitory action of immunological

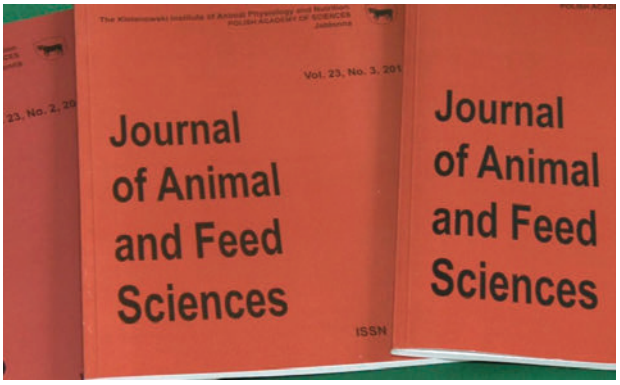
Tissue processing



Slices of the ovine hypothalamus (brain)

stress on reproductive function. During inflammation various mediators like interleukins and cytokines are activated in the CNS. These factors evoke changes in the secretion of GnRH/LH either directly via their own receptors or indirectly through intermediate regulatory neurons.

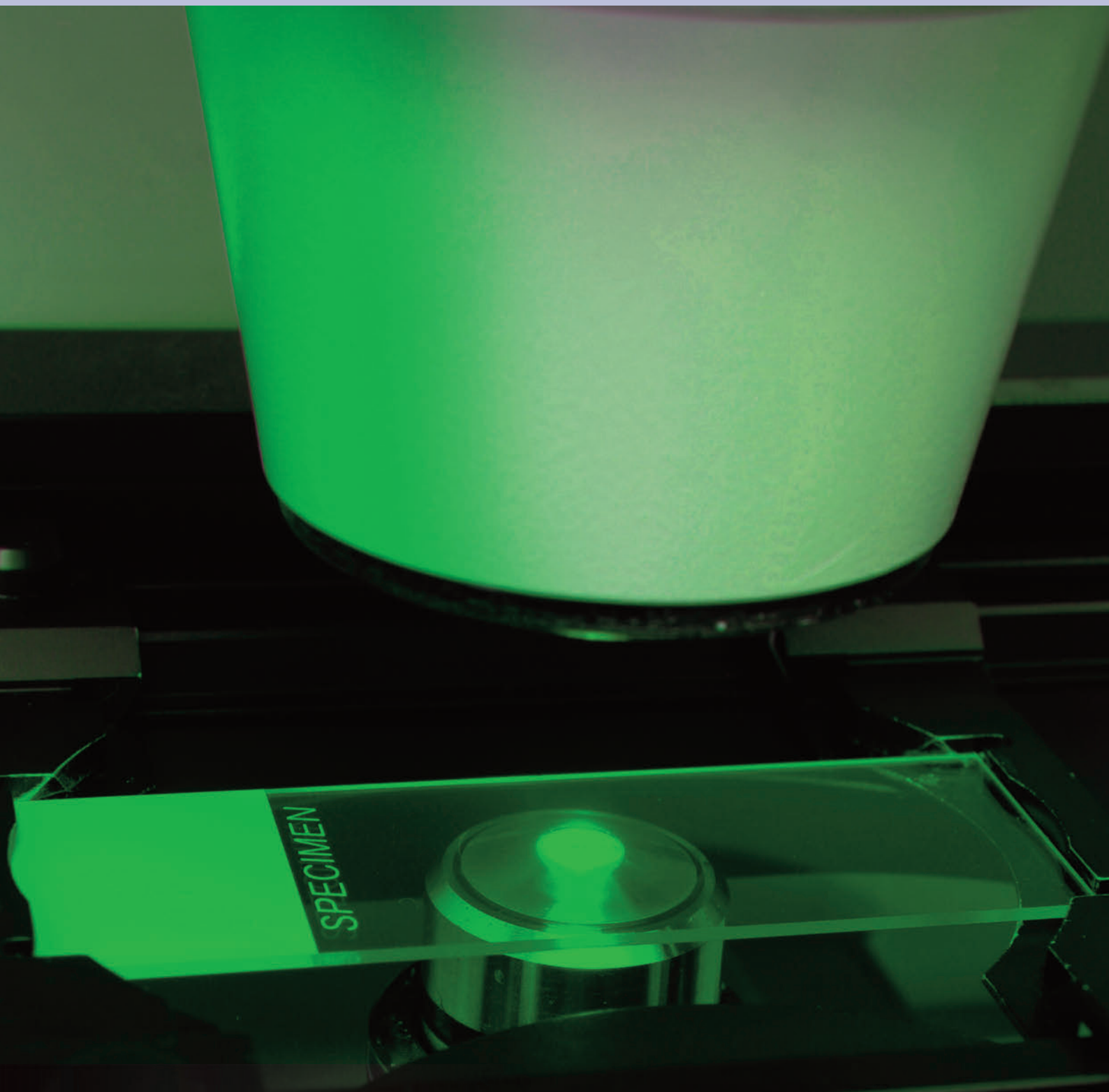
Another investigation studies the central mechanisms regulating the secretory activity of the pituitary during lactation. The development of the maternal behaviour, production and secretion of milk, reduction of responsiveness to stress, and the inhibition of reproductive activity are some of the hormonally regulated aspects of the adaptation of a lactating female. Our key achievement in understanding the regulation of these processes was the identification of salsolinol in the sheep hypothalamus and determination of changes in its secretion in response to suckling. Using the sheep model we showed that salsolinol has stimulatory properties in relation to prolactin and oxytocin, hormones strictly related to lactation, and that there is a relationship between the activity of endogenous opioid peptides and the synthesis of salsolinol in the hypothalamus. It is suggested that salsolinol may be an important terminal element in the sucking stimulus, encouraging the release of prolactin and oxytocin and making it possible to sustain increased secretion of both hormones during lactation. The latest data also shows that salsolinol participates in inhibiting the reaction of the corticotropic system to stressors, which would associate this molecule with the mechanism responsible for reducing the sensitivity of lactating mothers to stress.



Scientific journal published by the KIAP&N

Journal of Animal and Feed Sciences

The KIAP&N publishes its own quarterly international scientific journal, The Journal of Animal and Feed Sciences, in which original papers on basic and applied research in the field of animal breeding and genetics, physiology of nutrition, animal feeding, feed technology and food preservation are published.



Professor Tomasz Misztal
Director

The Kielanowski Institute of Animal Physiology and Nutrition
Polish Academy of Sciences
Tel: +48 22 7653301
Email: ofice@ifzz.pl
Web: www.ifzz.pl

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