

NATIONAL CENTRE FOR INFORMATION AND DOCUMENTATION

ADVANCES IN BULGARIAN SCIENCE



2 : 2006
: SOFIA
:

Published by National Centre for Information and Documentation
52 A G. M. Dimitrov Blvd
1125 Sofia, Bulgaria,
Phone: +359 2 817 38 62
[http: www.nacid.bg](http://www.nacid.bg)
e-mail: advances@nacid-bg.net

Editorial board:

Kamen Velev
Vanya Grashkina, Olga Racheva,
Yana Panova, Kostadin Tonev,
Milen Angelov, Tzvyatko Stoyanov
Lyudmila Velkova

Disclaimer

The articles are published as provided by their authors, without additional editing.

ISSN: 1312-6164

© National Centre for Information and Documentation 2005 - Publisher
© PrePress by Svetoslav G. Marinov Ltd., Sofia, Bulgaria
© Printing by Milena Print Ltd., Sofia, Bulgaria
© Cover design by Svetoslav G. Marinov Ltd., Sofia, Bulgaria

NATIONAL RESEARCH PROGRAM "INCREASING INNOVATIONS IN SMALL AND MEDIUM-SIZED ENTERPRISES"

"Cognition in all its forms today plays the main part in the economic process. Companies with more knowledge are winners on the market. Nations gifted with more knowledge are more competitive."

In the process of Bulgaria's joining the European Union it is necessary to increase the competitive power of Bulgarian small and medium-sized enterprises (SMEs) and their ability to withstand the competitive pressure and the market forces. Implementation of scientific achievements, new technologies and development of the innovation potential of enterprises is of decisive significance for strengthening of production, hence increasing of employment and achieving of economic growth.

Investments in applied research activities, technological development and innovations most of all exert influence on productivity and degree of added value of products and services offered on the market. Most of the enterprises yet have neither capacities to perform research activities by themselves nor qualified staff at their disposal to develop and introduce new technologies aiming at increase of volume and quality of production, development of new products, new design or other innovative activities. Due to these reasons they cannot use their innovation potential and cannot adequately meet the demands of the market.

Scientific applied research activity is a serious factor for innovations, but if there is no entrepreneurship, new business cannot be created. Enterprise is the unit that organizes business. Due to shortening of a product's life cycles enterprises face the necessity of more intensive capital investments and fast reaction. For them innovations are an important means for creation of competitive advantages and higher value for the clients.

Bulgarian authorities render an account of the necessity of supporting entrepreneurs in their efforts to develop enterprises and integrate them into the world markets. Estimating the importance of the innovation process, the state gives grants for applied research, development of new products, technologies and services, thus sharing the entrepreneurs' risks.

The efforts of the Bulgarian government are directed at creation of conditions for implementation of innovations in the result of investigations assisted by public funds and involvement of more private capital investments for financing market-oriented scientific applied research projects. Participation of the state in the innovation processes management is directed at creation of conditions and development of mechanisms motivating private entrepreneurs to undertake bigger risks and invest into market-oriented new products.

Economic growth and respectively increase of productivity definitely depend on the speed and effectivity of innovations dissemination in economy. Innovative solutions should penetrate in all spheres. The program "Increasing Innovations in Small and Medium-sized Enterprises" is in conformity with the long-term prognoses on development of economy, science, social life and inclusion of research units in the European Research Area.

Direct dialogue concerning research services and support in the field of innovation processes between small and medium-sized enterprises and the scientific research sector is realized through energetic activities of the National Science Fund at the Ministry of Science and Education and Innovation Fund at the Ministry of Economy and Energy of the Republic of Bulgaria. Favourable conditions are created for business, so that small and medium-sized enterprises could use science-consuming services.



NACID

National Centre for Information and Documentation

MAIN OBJECTIVES

NACID is a governmental institution affiliated to the Ministry of Education and Science. NACID collects, processes, maintains and disseminates reference and analytical information to support the national policy in the field of education, science and innovation as well as to support Bulgarian research bodies, individual researchers and SMEs

PRIMARY FIELDS OF ACTIVITIES

- Processing and disseminating bibliographic, reference data and analytical information
- Maintaining specialized databases of scientific production and research resources in Bulgaria
- Providing information about national, European and trans-European research programs
- Providing information to support the process of harmonization of the Bulgarian education and research legislation with European Union ones
- Performing the role of institutional contact point of the Sixth Framework Program in Bulgaria

INFORMATION PRODUCTS AND SERVICES

- ❑ NACID offers a large range of information products, including:
 - Subject profiles
 - Reviews
 - Bibliographic references
- ❑ NACID offers a great variety of information services through its own databases as well as information brokerage to external databases. Online access to two information blocks of *locally maintained own databases* in English:

"Bulgarian Science" Databases

- "SIRENA", R&D reports and dissertations - more than 80 000 records
- "Scientific and Technical Publications in Bulgaria" - more than 2 500 records
- "Who is Who in Bulgarian Science" - more than 5 500 records
- "Papers" - more than 130 records

" Science and Industry" Databases

- "Partnership for Innovation and Development" - Information about the national research units
- "Knowledge for Innovations and Development" - Information about Bulgarian R&D activities

The information brokerage services are available upon request, providing access to over 1200 databases from major international commercial host centers, thus providing the research community with a wealth of S&T information.

- ❑ *Central Research and Technical Library services*
 - Library collections - more than 4 million items/reference books, monographs, serials, dissertations, CD ROM, DVD etc.
 - Online access to the library catalogues since 1980
 - Searching in electronic catalogues and databases
 - Lending of library materials
 - Electronic Document Delivery
 - Interlibrary loan
 - More than 9000 users per year

CONTENTS



NATIONAL SCIENTIFIC PROGRAMMES WITH EUROPEAN DIMENSIONS 7

Lactic Acid Bacteria from Traditional Bulgarian Products and their Impact on Food Safety 7

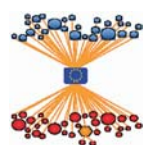


BULGARIAN ADDED VALUE TO ERA 23

Point L- BULGARIA Ltd. 23

ELTA-R - Traditions, Present and Future in the Building of Communication Systems and Networks 28

Innovation Policy in Bulgaria 35



MADE IN BULGARIA WITH EUROPEAN SUPPORT 39

Technology for Production of Heat Pipe Based on Process of Pressing One Material Complex 39

New Technology for Design and Manufacturing of Technology Equipment 40

A New Technology for Recycling of Thin and Strong, Very Dirty LDPE and LLDPE Film 41

Simplified Methodology for Modelling Ladies' Garments 41



EQUAL IN EUROPEAN RESEARCH AREA 42

BULGARIAN VIPs 42

AWARDS 44

ARTICLES 45



EVENTS 49





NATIONAL SCIENTIFIC PROGRAMMES WITH EUROPEAN DIMENSIONS

LACTIC ACID BACTERIA FROM TRADITIONAL BULGARIAN PRODUCTS AND THEIR IMPACT ON FOOD SAFETY

Iskra Ivanova, Biological Faculty, Sofia University "St. Kliment Ohridski",

e-mail: vitanova@biofac.uni-sofia.bg

Svetla Danova, Institute of Microbiology «Stephan Angeloff», BAS, Bulgaria

Introduction

Lactic acid bacteria (LAB) are one of the microorganism groups widely distributed in the biosphere. They belong to a group of Gram-positive anaerobic bacteria that excrete lactic acid as their main fermentation product into the culture medium. LABs are among the first organisms to be used in food manufacturing. Today LABs play crucial roles in the manufacturing of fermented milk products, vegetables and meat, as well as in of the drug to the intracellular target. LABs have been studied extensively and are now among the best-characterised microorganisms with respect to their genetics, physiology and applications (Todd Klaenhammer et al., 2002). Detailed knowledge of a number of physiological and biochemical traits of LAB strains can open new potential applications for these organisms in the food industry, while other traits might be beneficial for human health.

1. Traditional Bulgarian products:

Milk and milk products are excellent natural sources of LAB. In the recent years intensive studies are performed with LAB isolated from different ecological niches. The study of strains isolated from artisan milk products and traditional products from countries and regions that have saved the existing technologies and natural starter cultures is of special interest. Bulgaria is the native land of yogurt. The present paper deals with the investigations during the last ten years on isolation and characterization of LAB

from traditional Bulgarian products: yogurt, white cheese, yellow cheese (kashkaval), and boza.

1.1. Brief description of the Bulgarian products:

Yogurt: (also spelled yogourt or yoghurt) is a semi-solid fermented milk product, which originated centuries ago in Bulgaria. Its popularity has grown and it is now consumed in most parts of the world. Consumption in Bulgaria is 45 kg/person/year.

White Cheese -Traditionally cheese was made as a way of preserving the nutrients of milk. In a simple definition, cheese is the fresh or ripened product obtained after coagulation and whey separation of milk. The Bulgarian white cheese is milk product manufactured from cow, sheep, buffalo cow and goat milk or their mixture by coagulation with special enzymes and after lactic acid fermentation. The lipids and proteins in the product are concentrated. The taste is formed by addition of different quantity of salt. Bulgarian market offers several different kinds of white cheeses. Consumption background: 14-15 kg/person/year- third place in the world.

Yellow Cheese (Kashkaval). This product is prepared with thermo treated raw cow and sheep milk after fermentation by LAB and enzymes modulation and after a period of ripening. Two kinds of kashkaval are offered on Bulgarian markets - "Vitosha" (from cow milk) and "Balkan" (from sheep milk).

Curd izvara is a protein milk product produced from milk and whey and also their mixture after coagulation caused by LAB and enzymes. This product very often contains different lipids and other components.

Boza is widely consumed by people of all ages in the Balkan Peninsula. It is a viscous non-alcoholic beverage produced from different cereals (or mixture of them) and slightly fermented. Little information is available about its microflora.

1.2. Historical notes:

As far as the origin of the Bulgarian yoghurt is concerned, we lack reliable data. The beginnings of Bulgarian yoghurt production should be traced back to the Thracian tribes populating our territories. Being good farmers and stockbreeders, they kept large sheep flocks and no wonder that they found a natural way of obtaining it by boiling the milk and using ferment from the previous day for the next one. These methods practically resulted in specific microflora selection and, respectively, in differentiation of yoghurt from other lactic acid products. This inevitable way of lactic acid product emergence and establishment, including the Bulgarian yoghurt, reveals the impact of two major factors: the type of the regions, lactic acid microflora as the initial source of a desired bacterial starter culture as well as our ancestors' experience and traditions which contributed to the purposeful selection and manifestation of that microflora. Consequently, the formation of the Bulgarian yoghurt resulted from both ecological and technological factors.

In 1905 in Geneva the Bulgarian scientist Stamen Grigorov discovered the microflora of the Bulgarian yoghurt. This practically marked the beginning of the research on it, the name *L. bulgaricus* being connected with its discoverer's nationality.

With the perfection of bacteria differentiation methods, the type characteristics of lactic acid microorganisms in our yoghurt have been identified as *L. bulgaricus* and *Str. thermophilus*. This is corroborated in the definition of the International Dairy Federation concerning the product manufactured in other countries under

the name of yoghurt. In yoghurt where producers have been careless as to the hygiene requirements most often along with *L. bulgaricus* and *Str. thermophilus*, yeast and moulds have been detected.

The first study of the original microflora of yoghurt from different regions of Bulgaria, Yugoslavia, Turkey and Macedonia found, on the base of the isolation of strains of lactic acid rod-like bacteria: 70% of which were identified as *L. bulgaricus*, 39% as *L. jugurti* and a strain of *L. helveticus*. Systematic study of the type characteristics of lactic acid rod-like bacteria strains isolated from market yogurt established also the presence of *L. jugurti*, *L. helveticus*, *L. fermentum*, *L. plantarum*, *L. casei* ssp. *rhamnosus*, *L. acidophilus*. Grigorov and other authors consider the presence of other types of lactic acid rod-like bacteria and strain variety in the original yogurt to be something entirely normal providing *L. bulgaricus* is qualitatively dominant, but exclusively *L. bulgaricus* is essential to the industrial production of yoghurt with its characteristic organoleptical properties. Yoghurt could be considered as a relatively simple system with only two components of the starter - *L. bulgaricus* and *Str. thermophilus* and a short production time allowing following easily the antimicrobial activity.

1.3. Yogurt microflora and starters

Starter cultures refer to the specific lactic bacteria (LAB) which are used to inoculate milk and whose metabolism leads to the characteristics of the fermented milk product. The natural microflora of milk is inefficient, uncontrollable and unpredictable, or is destroyed altogether by the heat treatments given to the milk. A starter culture can provide particular characteristics in a more controlled and predictable fermentation. The primary function of lactic starters is the production of lactic acid from lactose. Other functions of starter cultures may include the following:

- Flavour, aroma, and alcohol production
- Proteolytic and lipolytic activities
- Inhibition of undesirable organisms

There are two types of starter cultures. The first traditional method contains complex

poorly defined mixtures of bacterial strains. The second type is called a "defined" or "selected" culture, and contains one or more identified pure strains with specific known properties. Specific criteria for culture selection include the LAB's rate of producing acid, their capacity for polysaccharide production, their limited proteolysis (which sometimes leads to bitter compounds) and their production of aromatic (flavour) compounds.

Starter cultures may be categorized as mesophilic or thermophilic:

Mesophilic Lactococcus lactis subsp. *cremoris* *L. delbrueckii* subsp. *lactis* *L. lactis* subsp. *lactis* biovar *diacetylactis* *Leuconostoc mesenteroides* subsp. *cremoris*;

Thermophilic Streptococcus salivarius subsp. *thermophilus* (*S. thermophilus*) *Lactobacillus delbrueckii* subsp. *bulgaricus*, *L. delbrueckii* subsp. *Lactis*, *L. casei* *L. helveticus* *L. plantarum*.

Mixtures of mesophilic and thermophilic microorganisms can also be used as in the production of some cheeses. Another criterion for starter selection is based on the LAB's ability to increase the nutritional and/or physiological value of the food, thus resulting in health properties.

1.3.1. Some traits of new LAB starters

Str. thermophilus is one of most economically important LAB used in the manufacture not only of yogurt but also of several fermented dairy foods. Its use increased significantly during the past two decades as a result of increase of consumption of these products. In 1998 more than 2.24 billion pounds Mozzarella cheese and 1.37 billion pounds of yogurt were produced respectively with a combined economic value of nearly 55 billion. (Klaenhammer T. et al., 2002) This increase led to new demands on the performance and production requirements of such starter cultures. Industrial strains, for example, should be insensitive to bacteriophage, have stable fermentation characteristics and produce products having consistent flavour and texture properties. Although research on the physiology of the most important starters - *L. bulgaricus* and *S. thermophilus* revealed important information on some of these properties, including sugar

and protein metabolism, polysaccharide production and flavour generation, only recently the genetic basis of many of these traits was determined. Since bacteriophage are responsible for considerable economic losses during cheese manufacture, efforts are underway to engineer restriction and other phage-resistance systems into commercial strains. Recently special attention is paid to the biological activity and bioprotective role of LAB starters with the accent on activity against food spoilage and food-borne pathogens (*Bacillus cereus*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Salmonella* spp., *Escherichia coli*, *Campylobacter jejuni*).

• Anti-microbial activity of LAB

Lactic acid bacteria are a fruitful source of antibacterial substances including organic acids, hydrogen peroxide and bacteriocins, which play an important role in food preservation. Bacteriocins are extensively studied both from scientific and industrial point of view due to the possibility of using them as safe natural food additives for elimination of spoilage and pathogenic microflora and extension of the shelf life of the products.

A large number of well-characterized bacteriocins with different properties have been already described and characterized with respect to biochemical properties and structure, activity spectrum, genetic determinants and mechanism of action. Four different classes of bacteriocins in LAB have been established (Piard and Desmazaud 1992; Klaenhammer 1993; Nes et al., 1996):

- I - lantibiotics;
- II - small heat stable non-lantibiotic bacteriocins;
- III - large heat labile bacteriocins;
- IV - complex bacteriocins with lipid and carbohydrate moiety.

Nisin, a bacteriocin produced by certain strains of *Lactococcus lactis*, is the best-characterized inhibitor up to date. The producing strains are not equally distributed among LAB species and the production of multiple bacteriocins is common, too (Nettles and Barefoot, 1993; Nes et al., 1996). They are active usually against closely related LAB species, but in many cases activity against heterologous strains, considered as food spoilage and food pathogens has been reported

(Harris et al., 1989, Hechard et al., 1993, Vignolo et al., 1993, Skytta et al., 1993). Investigation of the bacteriocin mode of action resulted in current models, based on pore formation in the membranes of the target cells either by direct insertion in the phospholipid bilayer (lantibiotics) or after interaction with a putative receptor (Abee, 1995; Nes et al., 1996; Cenatiempo et al., 1996).

Extensive genetic studies in the recent years led to the general concept that the genes encoding the bacteriocins of Gram-positive bacteria including LAB are present in operon-like gene clusters, which harbour structural genes and genes for immunity, processing, maturation, regulation and translocation functions (Klaenhammer 1993; Jack et al., 1996). A large number of these genes have been cloned and sequenced. The data accumulated for different bacteriocin operons show only in some cases a high conservation in the primary sequence of the encoded genes or in their general organisation. Thus, the immunity gene may be located closely to the bacteriocin structural genes (van Belkum et al., 1991) and in others may be separated (Gonzales and Kunka, 1987; Schved et al., 1993; Jimenez-Diaz et al., 1993). Little homology has been found among the different immunity genes so far studied and the mechanisms conferring resistance of the producing cells to their bacteriocin are not yet well understood. The secretion of bacteriocins may occur by sec-dependent export or via ABC exporters. Recent studies revealed a new three component mechanism of regulation of bacteriocin synthesis including the action of an inducing factor in addition to the two components histidine protein kinase and response regulator (Nes et al., 1996). Further studies will be necessary in order to understand the mechanisms and interaction of all these processes. The molecular mechanisms of biosynthesis regulation, immunity and the mode of action on the target cells are the most intriguing and challenging problems in the field of bacteriocin research today. Investigations of different newly isolated bacteriocins could also open new possibilities to achieve a more efficient production and to improve the stability and activity of bacteriocins in natural food systems. The large number and heterogeneity of bacteriocins

so far isolated, with a contrasting low number of applications, supposes that new and more interesting bacteriocins and production systems of these antibacterial substances will appear.

The aim of using bacteriocins to improve the microbial quality and safety of food has stimulated intensive research efforts in recent years.

2. LAB from Bulgarian products as producers of antimicrobial substances with impact on food safety

Since food safety has become as increasingly important international concern, the application of antimicrobial peptides from lactic acid bacteria that target food pathogens without toxic or other adverse effects has received great attention. Recent outbreaks of emerging pathogens such as *L. monocytogenes* have prompted the food industry, the public, as the government to question the adequacy of current methods of food preservation. The consumption of more food formulated with chemical preservatives has also increased consumer concern and created a demand for more natural and minimally processed food. As a result, there is great interest in naturally produced antimicrobial agents.

Bacteria are a source of antimicrobial peptides, which have been examined for application in microbial food safety. Among gram-positive bacteria, the lactic acid bacteria have been comprehensively exploited as a reservoir for antimicrobial peptides with food application. Since bacteriocins are isolated from foods such as meat and dairy products, which normally contain LAB, they have unknowingly been consumed for centuries.

2.1. Isolation and characterization of bacteriocin-producers LAB from Bulgarian products

Despite the numerous reports for bacteriocin producers among LAB presented in dairy products the isolation and characterization of new active strains is interesting and presents an opportunity for development of "natural" or "minimally processed" food.

Different strains of *Lactobacillus delbrueckii* subsp. *bulgaricus*, *Streptococcus*

thermophilus and other species of LAB are currently used as starters in Bulgarian dairy products. The study of bacteriocin production of these species is important in several aspects. One is the proper choice of components of the starters, which should not negatively influence the growth and activity of each strain. Another aspect is the possible use of bacteriocins as natural preservatives against food borne pathogens such as *Listeria*, *Clostridium*, *E. coli*. An extensive screening of large number of strains isolated from artisan Bulgarian products for bacteriocin production was performed in an attempt to find new molecular entities with improved spectra and stability.

2.1.1. Screening of strains for antimicrobial activity

The screening included over 300 lactic acid bacterial strains isolated from traditional Bulgarian dairy products - yogurt, izvara, white cheese and yellow cheese (Kashkaval). Some of them belong to the species *Streptococcus thermophilus*, *Lactobacillus delbrueckii* subsp. *bulgaricus*, *Lactobacillus helveticus* and *Lactobacillus casei*. These species are commonly met in yogurt and other dairy products. A large group of not identified *Lactobacillus* strains, isolated from Kashkaval; a small group of *Lactococcus* spp. and Enterococci were studied, too. Initially the antagonistic activity of the strains was tested by the

agar spot method against several LAB and food spoilage species (*L. bulgaricus*, *Str. thermophilus*, *Lc. cremoris*, *Leucostonoc*, *E. coli*, *B. subtilis* and *L. innocua*). Strains with antimicrobial activity on solid agar medium were found in all five groups as listed in Table 1. Further screening by the well diffusion assay resulted in selection of strains, which retained activity under conditions eliminating possible effect of organic acids and hydrogen peroxide. Pronase treatment was applied in order to prove the proteinaceous nature of the active substance. Most of the strains did not change their activity after boiling at 100 °C for 15 min. Few strains possessed heat sensitive activity. The screening results are presented in Table 1.

Thirty-six strains showed antimicrobial activity, which was supposed to be due to bacteriocin synthesis (Table 1). Distribution of active strains among the studied species differed (Fig. 1). Although nearly one hundred *S. thermophilus* strains were screened, only three of them showed antimicrobial activity. The largest number of active strains was selected among the *Lactobacillus* strains isolated from yellow cheese. Over 30% of them exhibited antagonistic activity.

The activity of each strain was also tested against other strains from the same species (Table 2), which allowed confirming that bacteriocins inhibit closely related strains. All active strains showed antagonistic activity against the LAB

Table 1. Summary of investigation of antibacterial activity of Bulgarian lactic acid bacteria isolated from traditional dairy products

Lactic acid bacteria*	Number of strains		
	tested	active By colony method	By diffusion method
1. <i>Streptococcus thermophilus</i>	100	3	3
2. Lactococci from boza	45	11	8
3. Enterococci from dairy products	14	3	1
4. <i>L. delbrueckii</i> subsp. <i>bulgaricus</i>	130	13	9
5. <i>L. helveticus</i>	11	3	3
6. Lactobacilli from yellow cheese			
6.1. <i>L. casei</i>	12	2	2
4.2. <i>L. delbrueckii</i> subsp. <i>Bulgaricus</i>	52	19	19
Total number of strains	364	54	47

*All strains originated from Bulgarian products. Part of these results was already published (Miteva et al, 1998)

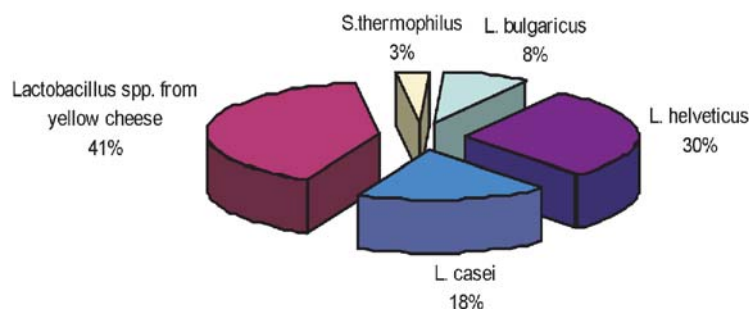


Fig. 1. The presence of bacteriocinogenic strains among tested LAB species isolated from Bulgarian dairy products

Table 2. Summary of results from inhibitory spectrum of bacteriocin -producers LAB*

Producers strains	No tested/ No active against selected test - microorganisms										
	E.coli	B.cereus	B.subt.	Linn.	Lbulg.	S.term.	L.crem.	Leuc.	L.acid.	L.lactis	L.helv.
from species:											
Lbulgaricum	9/4	9/7	9/5	9/2	9/5	9/3	9/4	9/1	9/1	9/0	9/5
Lhelveticus	3/1	3/1	3/1	3/1	3/3	3/2	3/2	3/0	3/2	3/0	3/1
Lb.from yellow cheese	21/12	21/6	21/19	21/8	21/11	21/16	21/5	21/4	21/7	21/3	21/4
S.termophilus	3/3	3/1	3/3	3/3	3/0	3/3	3/0	3/0	3/1	3/0	3/1

* The full spectrum of activity of all bacteriocinogenic strains was published by Miteva V. et al., 1998 and Ivanova I. et al., 1998)

species, Gram-positive and Gram-negative bacteria used as tests. Table 2 presents summarized results of at least five different experiments for each producing strain.

In addition this assay resulted in selection of the most sensitive strains for each species. Among the *Lactobacillus* strains studied, four strains appeared to be highly sensitive to most of the selected bacteriocin producers. Three from the tested *S. thermophilus* strains, as well as one *Lc. cremoris* strain were also inhibited by most of the *Lactobacillus* bacteriocin producers. Thus, four *Lactobacillus* and three *S. thermophilus* strains were used as indicators in our further studies.

Most of the *L. bulgaricus* strains selected as bacteriocin producers were active against one or more closely related species. It is interesting that the *L. delbrueckii* subsp. *lactis* test used was not inactivated. Activity against food spoilage bacteria such as *E. coli*, *B. subtilis* and *B. cereus* was also revealed. Only two of these strains inhibited *L. innocua* as well.

The selected strains of *L. helveticus* demonstrated different activity. One strain had a wider spectrum including food spoilage bacteria and the other two inhibited mainly a limited number of LAB tests. *L. helveticus* and *L. casei* are reported to produce a number of bacteriocins, some of them being well characterized - lactocin 27 (Upreti and Hindstill, 1973), helveticin J (Joerger and Klaenhammer, 1986), helveticin V-1829 (Vaughan et al. 1992) and caseicin 80 (Rammelsberg and Radler, 1990)

The largest number of active strains with relatively broad inhibitory spectrum was selected from the group of *Lactobacillus* strains isolated from yellow cheese. Nearly all of them exhibited activity against some of the closely related LAB tested. A small group of five *Lactobacillus* strains displayed a remarkably wide spectrum. Another group of four strains was interesting with predominant inhibition of food borne pathogens and limited action on closely related LAB strains. And finally, one strain showed antagonistic activity only against *L. bulgaricus*, *Lc. cremoris* and *Str.*

thermophilus. The latter species and *B. subtilis* were the most sensitive to antibacterial activity of the selected strains, being inhibited by most of them.

The three selected strains of *Str. thermophilus* possessed nearly identical inhibitory spectra with expressed activity against the species representing the group of food spoilage bacteria *L. innocua*, *B. subtilis*, *B. cereus* or *E. coli* as well as against other *Str. thermophilus* strains. Almost total lack of activity against other LAB species was observed. At the same time *S. thermophilus* and especially *L. delbrueckii* subsp. *bulgaricus* appear as rare bacteriocin producers. The reported bacteriocins from *S. thermophilus* usually inhibit only closely related LAB species (Cilano et al. 1990; Marciset and Mollet, 1993; Ward and Somkuti, 1995) and only one had antilisterial activity (Villani et al. 1995). The only bacteriocins from *L. delbrueckii* reported so far are lactobacillin EG4 and lacticin A and B, synthesized by *L. delbrueckii* subsp. *lactis* (Giraffa et al. 1989; Toba et al. 1991).

During an extensive screening of lactic acid bacteria (LAB) isolated from Bulgarian dairy products, a group of 52 *Lactobacillus* strains from yellow cheese was found to contain the largest number of bacteriocin producers - 19. Twenty strains were selected, which inhibited one or more LAB species, as well as *E. coli* and *Bacillus subtilis*. Taking into consideration the fact that the groups of studied strains belong to the species *L. delbrueckii*, *L. helveticus*, *L. casei* and *Streptococcus thermophilus* it could be noted that un-

like *L. helveticus* and *L. casei*, known as good bacteriocin producers, the two yogurt starters *L. bulgaricus* and *S. thermophilus* are rare producers. In this respect the selection of nine *L. bulgaricus* (from twelve bacteriocinogenic) strains active against food born and food spoilage bacteria is a promising fact. Two strains: *L. delbrueckii* and *S. thermophilus* 81 were studied in more details.

2.1.2. *Lactobacillus delbrueckii* and *S. thermophilus* 81- producers of bacteriocins

• *Inhibitory activity and spectrum*

Lactobacillus delbrueckii 1043 and *S. thermophilus* 81 were found to possess antibacterial activity both by the agar spot method and by the well diffusion method. While *S. thermophilus* 81 inhibits only few strains from the group of closely related LAB species, the strain *Lactobacillus* 1043 was active against one or more strains from nearly all *Lactobacillus* species tested (*L. delbrueckii*, *L. helveticus*, *L. acidophilus*, *Streptococcus thermophilus*, *Lactococcus cremoris*, *Leuconostoc mesenteroides* and *Carnobacterium piscicola* (Table 3). A wide spectrum of activity was detected against the test strains representing the species of food-borne pathogens. Four strains of *E. coli* were sensitive to the active substance; the pathogenic strains of *Listeria monocytogenes* studied and the non-pathogenic strain, *Listeria innocua* F, were also inhibited, as well as several *Bacillus* species, *Staphylococcus aureus*, *Yersinia enterocolitica*, *Yersinia pseudotuberculosis* and *Enterococcus faecalis* (Table 4).

Table 3. Activity of strain *Lactobacillus delbrueckii* 1043 against closely related LAB species

Indicator species	No of strains inhibited/ No of strains tested	
	<i>S. thermophilus</i> 81	<i>L. delbrueckii</i> 1043
<i>L. delbrueckii</i> subsp. <i>bulgaricus</i>	1/7	4/4
<i>L. delbrueckii</i> subsp. <i>lactis</i>	0/1	1/2
<i>L. helveticus</i>	0/4	1/3
<i>L. acidophilus</i>	1/1	1/1
<i>L. casei</i>	0/2	0/2
<i>Lactobacillus plantarum</i>	0/1	0/2
<i>S. thermophilus</i>	3/8	3/8
<i>Lactococcus lactis</i> subsp. <i>cremoris</i>	0/1	1/1
<i>Leuconostoc mesenteroides</i>	0/2	1/2
<i>Pediococcus damnosus</i>	0/1	0/1
<i>Carnobacterium piscicola</i>	2/2	1/2

Table 4. Wide spectrum of inhibitory substances produced by *Lactobacillus delbrueckii* 1043 and *S. thermophilus* 81 strains

Indicator species	No of strains inhibited/ No of strains tested	
	<i>S. thermophilus</i> 81	<i>L. delbrueckii</i> 1043
<i>Bacillus subtilis</i>	2/3	2/2
<i>Bacillus cereus</i>	1/1	1/1
<i>Escherichia coli</i>	3/6	4/6
<i>Streptococcus faecalis</i>	1/1	1/1
<i>Staphylococcus aureus</i>	0/1	1/1
<i>Listeria innocua</i> F	1/1	1/1
<i>Listeria monocytogenes</i>	4/4	4/4
<i>Salmonella typhimurium</i>	1/1	1/1
<i>Yersinia pseudotuberculosis</i>	1/1	1/1
<i>Yersinia enterocolitica</i>	1/1	1/1

The strains *Lactobacillus delbrueckii* 1043 and *Str. thermophilus* T81 were chosen for further studies because of their wide inhibitory spectrum (Table 4). Activity against *E. coli* was reported for bacteriocin-producing strains of *Pediococcus damnosus* and *Lact. Casei* (Vignolo et al., 1995; Skytta et al., 1993). Our bacteriocin appeared to be active against a range of food-borne pathogens such as *L. monocytogenes*, *Staph. aureus*, *Y. enterocolitica* and *Y. pseudotuberculosis*. Inhibition of food-borne pathogens has been reported for bacteriocin producers isolated from meat. The application of such a broad spectrum bacteriocin, or the producer strain, could result in improvement of starter cultures and dairy product preservation. An important point is the relatively low sensitivity of other *Lactobacillus* and *Str. thermophilus* strains, as a possible inhibition of the other components of the starters, which would negatively influence the balance and fermentation properties of the starters.

• Molecular identification of *Lactobacillus* strain 1043

Lactobacillus 1043 was initially identified by classical tests as *Lact. bulgaricus*. But it needed more precise and reliable identification. Different molecular approaches were applied for this purpose. In dot - hybridization analysis of genomic DNAs, two DNA probes - one, specific for the whole species *Lact. delbrueckii* with its three subspecies - subsp. *delbrueckii*, subsp. *bulgaricus* and subsp. *lactis* and another - for *L. helveticus* were used (Delley et al., 1990; Pilloud

et al., 1990). A strong signal was detected with the probe for *L. delbrueckii* and no signal with the *L. helveticus* probe. These results definitely proved the affiliation of *Lactobacillus* 1043 to the species *L. delbrueckii*.

Our further attempts were aimed at identification of the studied strains at subspecies level by application of other molecular typing methods and using reference strains from the three subspecies of *L. delbrueckii*. M13 genomic DNA fingerprinting was not successful as the profiles were highly similar. Much higher level of strain specificity was achieved by ribotyping with the universal pKK3535 probe, carrying the whole *rrn* operon of *E. coli*, especially after Hind III and Dra I digestions (data not shown). Strain 1043 clustered together with the reference strain *L. delbrueckii* subsp. *bulgaricus* ATCC 21815 and one of the reference strains from subsp. *lactis* - ATCC 12315. This cluster was closely connected to a group of four *L. delbrueckii* subsp. *bulgaricus* references. At the same time the second *L. delbrueckii* subsp. *lactis* strain - NCDO 297 and *L. delbrueckii* subsp. *delbrueckii* ATCC 9649 showed very low similarity to all other strains. At the moment, the strain cannot definitely be affiliated to any of the three subspecies, *L. delbrueckii* subsp. *delbrueckii*, *L. delbrueckii* subsp. *lactis* or *Lact. delbrueckii* subsp. *bulgaricus* as the three subspecies could not be differentiated by the methods used. Our preliminary conclusion, which requires further proof, is that strain 1043 belongs to *L. delbrueckii* subsp. *bulgaricus*.

• Plasmid content

The plasmid content of *L. delbrueckii* strain 1043 and *Str. thermophilus* were studied. The last strain did not possess a plasmid. Interestingly, it was found that *L. delbrueckii* 1043 had a large plasmid. Several variants lacking antibacterial activity were isolated after prolonged cultivation of the producer or heat treatment of the culture at 60°C. They retained the plasmid and even restored their activity after several passages. Our present results do not allow us to determine whether the bacteriocin synthesis genes have a plasmid or a chromosomal localization. Further studies of the genetic determinants of the isolated bacteriocin are in progress.

- *Production studies*

Production studies were performed in different media at different temperatures and both in non-regulated and regulated pH. The optimal cultivation conditions for bacteriocin synthesis were estimated. Lower temperature of cultivation (30 °C) and higher inoculum seemed to be important for better production. Our results suggested an induction effect of some components of the active cultures, as inactivation by proteases and adsorption on the producer cell were excluded.

- *Characterization of the inhibitory agents*

The activity of the inhibitory agents produced by *L. delbrueckii* 1043 and *S. thermophilus* 81 was tested under conditions, which eliminate possible effect of organic acids by adjusting the pH of the cell free supernatant to pH 7 and of hydrogen peroxide by catalase treatment. In both cases the activity was not affected.

The effect of various enzymes on the inhibitory substance in the cell-free supernatant and on the purified active substances was studied. Complete inactivation of bacteriocin produced by *S. thermophilus* 81 was observed after treatment with proteinase K and pronase E, which indicated the proteinaceous nature of the active agent. At the same time trypsin, chymotrypsin and proteases type IV and VII had no effect. The other enzymes tested in our study (several amylases, one neuraminidase and one lipase) did not cause inactivation. Table 4 presents the results with *E. coli* as an indicator strain. The

results with *L. innocua* were similar. Complete inactivation or significant reduction in activity of bacteriocin produced by *L. delbrueckii* 1043 was observed after treatment with proteinase K and pronase E, which indicates the proteinaceous nature of the active agent. In addition two amylases tested totally inactivated the studied substance, supposing the presence of carbohydrate moiety. The only lipase used caused a slight reduction of the activity. The antimicrobial substance in the neutralized active culture supernatant appeared to be heat stable even at 100°C and 121°C for 15 minutes. The pH stability of the culture supernatant was studied in the range from pH2 to pH12. The activity was stable under a wide pH range from 2 to 10.

The activity was not changed after storage at 4°C for more than two months and in frozen state - over 6 months.

The effect of detergents on different bacteriocins gives information about the structure of the active molecules. Anionic detergents often unfold proteins by complexing to the interior hydrophobic core of their native structure, which may affect their three dimensional conformation. The observed reduction or full loss of bacteriocin 81 activity, following treatment with SDS and N-lauryl sarcosine may be due either to partial denaturation or to disruption of its association with other molecules, having stabilizing effect on its activity.

During purification of produced anti-bacterial substances several different protocols were applied. Optimal recovery for *S. thermophilus* 81 was achieved by a combined protocol including ammonium sulphate precipitation, butanol extraction, HPLC gel chromatography and HPLC reverse phase chromatography. This protocol resulted in approximately 1400-fold increase in the specific activity and 5.4% recovery. The hydrophobic nature of bacteriocin 81 was evidenced by the butanol extraction and the HPLC elution profile. Additional proof gives the elution with 80% acetonitrile upon chromatography on Qg reversed phase column. Hydrophobicity is a common feature of several bacteriocins (Muriana and Klaenhammer, 1991; Piard et al., 1992).

A novel antibacterial substance from

Table 5. Factors affecting bacteriocin activity of *S. thermophilus* 81 (against *E. coli* C 600) and *L. delbrueckii* 1043 (against *L. innocua* F)

Treatment	Bacterion activity	
	<i>S. thermophilus</i> 81	<i>L. delbrueckii</i> 1043
<i>Enzymes</i>		
α - Chymotrypsin	+	+
Proteinase K	-	-
Pronase E	-	-
Protease type IV	+	+
Protease type VII	+	+
Trypsin	+	+
α - Amylase (aquazym)	+	+
α - Amylase (thermomyl)	+	+
Glucoamylase	+	+
Lipase A	+	+/-
Neuraminidase	+	+
<i>Surfactants</i>		
SDS	-	+
N -lauryl sarcosine	-	+
Triton X-100	+	+
Tween 20	+	+
Tween 80	+	+
Urea	+	+
<i>pH</i>		
2.0	-	-
3.0	+	+
4.0	+	+
6.0	+	+
8.0	+	+
9.0	+	+
10.0	+	+
11.0	+/-	+/-
12.0	-	-
<i>Heat</i>		
50°C,	+	+
60°C,	-	+
70°C,	-	+
80°C,	-	+
100°C	-	+
120°C	-	+

(+) - positive effect; (-) - negative effect

Lactobacillus strain 1043 was purified and characterized. The purification protocol applied resulted in a 3800-fold increase in specific activity with a recovery of 17%. The characterized inhibitory agent was not affected by detergents. In this respect it did not differ from most of *Lactobacillus* bacteriocins. High temperature stability is very convenient if the bacteriocin is to be used as a food preservative because many processing procedures involve heating. Sensitivity of the substance to *proteinase* K and *pronase* E is a

proof of its proteinaceous nature, which led to the assumption that it was a bacteriocin. Sensitivity of the cell-free supernatant fluid of *L. delbrueckii* 1043 and, more important, of the purified homogeneous substance to amylolytic enzymes and partially to lipase A, suggests that a lipid and carbohydrate moiety are important for the activity. This finding was supported by the yellow band observed after silver staining of SDS-PAGE gels, considered by other authors as an indication of lipids and sialoglycoproteins

(data not shown). The presence of carbohydrates in the purified preparation was confirmed by chemical estimation (10%) and proved the presence of a carbohydrate moiety in the active bacteriocin. The question of how this moiety is joined to the protein remains to be answered. The presence of carbohydrates is characteristic of the least-studied bacteriocins of class IV (Klaenhammer 1993; Nes et al., 1996). Lactobacilli have been known to be producers of class IV complex bacteriocins since the 70s (Upreti and Hinsdill, 1973; Piard and Desmazeaud, 1992). Recent data indicate that caution should be used as in some cases, such chemical moieties could be due to contaminants rather than being part of a real glycopeptide. The complex nature of the bacteriocin studied was confirmed during unsuccessful attempts to sequence the purified active peaks, possibly because of aggregation of several molecules. The fact that the samples were poorly soluble in water, and the observed slight reduction in activity after lipase A treatment, suggested a probable participation of a lipid moiety.

The bacteriocin was shown to be small (3-6 kDa) by three different methods – HPLC gel filtration, SDS-PAGE, and amino acid contents. It should be noted that electrophoretic separation of the purified bacteriocin was not always reproducible. A size discrepancy was observed, which is common to small peptides. This could also be due to a possibly complex structure of the antibacterial agent.

In conclusion, to our knowledge, this is the first data of a bacteriocin isolated from *L. delbrueckii* with characteristics such as a broad inhibitory spectrum, including food-borne pathogens, and a structure which allows it to be referred to class IV.

2.1.3. Characterization of a proteinaceous anti-bacteria and anti-yeast compound produced by *Lactobacillus paracasei* subsp. *paracasei* strain M3

In 1987, Silva et al. isolated a low-molecular-weight (< 1000) antimicrobial substance produced by *Lactobacillus casei* subsp. *ramnosus* GG. Rammelsberg et al. described a new bacteriocin from *L. casei* - caseicin 80. Hutten et al.

purified and identified 2-pyrrolidone-5-carboxylic acid (PCA) produced by *L. casei* subsp. *casei*, LC-10 and *L. casei* subsp. *pseudoplantarum* LB1931. Its spectrum of activity included several species of *Bacillus subtilis*, *Pseudomonas putida* and *Enterobacter cloacae*. Vignolo et al. (1993) reported the production of lactocin 705 by *L. casei*, CRL 705 from fermented sausages, showing their antilisterial activity.

However only few reports exist on specific antifungal and anti-yeast compounds produced by LAB. Fungi are a frequent cause of spoilage in foods; besides, they represent a considerable danger for human health as producers of mycotoxins. Most strains from the *Candida* family are particularly dangerous in this respect *Penicillium commune* commonly spoils hard cheese while different *Fusarium* species can produce mycotoxins in cereal grains. Yeasts *Candida parapsilosis* and *Debaryomyces hansenii* spoil yogurt and other fermented dairy products.

Most of the observations published in literature concern antifungal agents from LAB, which are mostly low-molecular-mass organic compounds, for example capric acid and several short-chain fatty acids in the case of an antifungal *Lactobacillus sanfrancisco* CBI strain from sourdough, benzoic acid methylhydantoin, mevalonolactone and cyclo-(glycyl-L-leucyl), synergists of lactic acid, isolated from *Lactobacillus plantarum* and active against *Fusarium avenacum*. Phenyl-lactic acid and 4-hydroxyphenyl-lactic acid produced by *L. plantarum* 21B were determined to have broad fungicidal activity. Early studies discovered antifungal activities produced by a *L. casei* strain, which inhibited both growth and aflatoxin production of *Aspergillus parasiticus*. Production of several fungal inhibitory compounds by *L. casei* subsp. *ramnosus* with molecular masses below 1 kDa was also evidenced.

Recently, Okkers et al. characterized bacteriocin-like peptides isolated from *L. pentosus* with fungistatic effect on *Candida albicans*. Magnusson and Schnurer studied the production of proteinaceous antifungal substance by *L. coryniformis* subsp. *coryniformis* Si3 that is inhibitory against a broad range of filamentous fungi, moulds and to a lesser extent against yeasts. Fi-

Table 6. Activity spectrum of bacteriocin produced by the strain *L. paracasei* M3

Test strain (sources)	Activity of <i>L. paracasei</i> M3 (Diameter in mm of the zone of clearing)
<i>Bacteria</i>	
<i>Bacillus subtilis</i> ATCC 6633 (soil)	20
<i>Lactobacillus delbrueckii</i> ssp. <i>lactis</i> (5 strains; Bulgarian yoghurt and cream)	12
<i>Lactobacillus delbrueckii</i> ssp. <i>bulgaricus</i> (11 strains; Bulgarian yoghurt)	15
<i>Helicobacter pylori</i> 230 (human source, ISUL, Bulgaria)	18
<i>Yeasts</i>	
<i>Candida albicans</i> NBIMCC 72, strain SU, DMC	12
<i>Candida blankii</i> NBIMCC 85 (type strain)	15
<i>Candida pseudointermedia</i> NBIMCC 1532 (decayed wood)	20
<i>Saccharomyces cerevisiae</i> NBIMCC 1812 (palm wine)	15

nally, Corsetti et al. evaluated highly the potential of certain microorganisms with therapeutic properties for the prevention and/or treatment of selected intestinal and vaginal infections. Their study shows that among other strains, *L. casei* GG, producer of a microcin, can be used successfully for the prevention of antibiotic associated diarrhea and various other diarrhea illnesses as well as against recurrent candidal vaginitis.

New proteinaceous active substance produced by *Lactobacillus paracasei* subsp. *paracasei* strain M3 used as a starter for Bulgarian yellow cheese was identified and studied. It displayed bactericidal and fungistatic activities (Table 6). Its activity was checked against over 60 bacteria. The produced substance was efficient against *Bacillus subtilis* ATCC 6633, several *Lactobacillus delbrueckii* species, *Helicobacter pylori* NCIPD 230 and some yeast species like *Candida albicans*, *Candida pseudointermedia* NBIMCC 1532, *Candida blankii* NBIMCC 85 and *Saccharomyces cerevisiae* NBIMCC 1812.

The synthesis of the substance by producing strain was detected in the late logarithmic growth phase during batch fermentation. Anion exchange chromatography, reversed phase chromatography on C₄ column and HPLC on C₁₈ column were used for partial purification of this antimicrobial compound. The gene responsible for the synthesis of the active substance is located on the bacterial chromosome.

The obtained results confirm the interest and possibility of using LAB with CRAS (*Generally regarded as safe*) status as a protection against fungal spoilage and mycotoxin formation

and as such they can present promising option for both food industry and agriculture.

2.1.4. Bacteriocin-like compound produced by *Enterococcus faecalis* A2000

The other interesting group that also fits within the general definition of LAB are the Gram-positive bacteria - Enterococci. Modern classification methods prompted the transfer of some members of the genus *Streptococcus*, notably some of the Lancefield's group D streptococci, to the new genus *Enterococcus*. Enterococci can be also used as indicators of fecal contamination. They have been implicated in outbreaks of food borne infections, and they have been ascribed simultaneously beneficial or detrimental role in foods. In processed meats, Enterococci may survive heat processing and later on cause spoilage, though in some cheeses the growth of Enterococci contributes to ripening and development of flavour. Some Enterococci of food origin produce bacteriocins that exert *anti-Listeria* activity. Despite these double beneficial and sometimes detrimental influences Enterococci are used often as probiotics improving the microbial balance of the intestine, or as a treatment of gastroenteritis in humans and animals.

The percentage of microorganisms producers of bacteriocins active against Gram-negative ones is very low. These compounds possess relatively narrow spectrum of activity oriented mainly against taxonomically close microorganisms, which determine genus *Enterococcus*. They represent an interesting and very perspective group of bacteriocin producers since they are

active against a lot of pathogens among the *Enterococcus* genus, and because of the phylogenetic propinquity to genus *Listeria*, with the representative *Listeria monocytogenes*, which causes listeriose.

Consequently, isolation of strains of LAB that produce bacteriocins active against Gram-positive and Gram-negative microorganisms is interesting in both practical and fundamental aspects. Recently a small hydrophobic peptide substance {*Enterococcin A*. 2002a) with a broad spectrum of antimicrobial activity has been purified (Pantev et al., 2002a). The strain *Enterococcus faecium A 2000* isolated from the surface of the traditional Bulgarian yellow cheese "kashkaval" produced a novel broad-spectrum anti-microbial peptide named *Enterococcin A 2000* active against Gram-positive and Gram-negative microorganisms including *Listeria* subsp. and *Escherichia coli*. The wide range of antibacterial activity including different lactic acid bacteria, pathogenic strains {*Listeria* and *Bacillus*}, as well as some Gram-negative species {*Escherichia coli*, *Salmonella typhimurium*, *Yersinia pseudotuberculosis*) suggests one mechanism of action. The influence of the nitrogen sources and of their concentrations on the production of *Enterococcin A 2000* was studied. Medium composition, especially concentration of peptone and yeast extract, influenced bacteriocin production showing its increase even in the absence of one of the compounds naturally present in MRS medium (Pantev A. et al., 2002b)

2.1.5. Occurrence of bacteriocinogenic LAB in Traditional Bulgarian cereal beverage (boza)

Cereals are subjected to fermentation in almost all regions of the world where cereals are consumed as staple food and therefore variety of raw materials and conditions of perspective fermentations are quite large. In these fermentations lactic bacteria are the predominant organisms together with yeasts. Natural combination of these two groups of microorganisms was used for centuries in the production of boza. It is a Bulgarian traditional based on cereals drink widely consumed by people of all ages in the Balkan Peninsula. Preparation of this indig-

enous drink generally depends on a spontaneous or change inoculation by naturally occurring LAB and the use of starter culture is rare. In our opinion boza seemed to be a promising source of antimicrobial substances.

The antagonistic activity of lactic acid strains isolated from boza was performed. As a result of intensive screening of 140 strains (LAB and yeasts) 25 strains were found to produce bacteriocin-like substances. The strain identified by physiological and biochemical techniques as *Lactococcus lactis* subsp. *lactis* B14 was used as producer of antimicrobial substance (Ivanova et al., 2000). A bacteriocin from *Lactococcus lactis* subsp. *lactis 14* named Bozacin 14 was isolated.

The summarized data based mainly on the results of the biological activity of the Bulgarian LAB proved that the studied Bulgarian food products are a promising source of active starters. Bacteriocinogenic LAB occur naturally as an indigenous microflora in Bulgarian food products. Numerous strains of these bacteria produced bacteriocins with activity against many species and genera. Identification of these substances with broad inhibitory spectra against spoilage and pathogenic microorganisms has gained interest towards their application as food preservatives in dairy systems.

Rational applications of bacteriocins require also an understanding at the molecular level of how bacteriocins exert lethality.

3. Mechanism of action of bacteriocins produced by Bulgarian LAB strains against sensitive cells

Early on, the dissipation on proton motive force was identified as a common mechanism for the lethal activity of LAB bacteriocins.

Quite a number of the bacteriocins manifest their inhibiting effects changing the permeability for different ions and metabolites of cytoplasmic membranes of the targeted cells. For this reason, intact liver mitochondria and artificial phospholipid liposomes were used as model systems in the study of *enterococcin A 2000* mode of action. It has also been studied how the pH of the reaction medium affects interactions between enterococcin and liposome membranes.

3.1. Testing of bacteriocin from *Lactobacillus delbrueckii* 1043 on eukaryotic cells

The mode of action of various bacteriocins and other ionophores have been extensively studied in membrane vesicles and artificial membranes during the last 10 years (Christensen B et al., 1998; Montville & Chain, 1998). On the other hand, eukaryotic cells are a natural system for testing of the wide variety of pore forming molecules, including bacteriocins (Kordel et al., 1986).

The advantages of such testing are:

- The existence of a native membrane composed of natural phospholipids and membrane incorporated protein structures, possessing fluidity and surface charge typical for the living cells.
- The presence of native intracellular signalling systems of second-messenger molecules and enzyme complexes, allowing adequate cell reactivity toward the bacteriocin tested and triggering of cellular reactions directed to neutralisation of the bacteriocin-induced injury.

Testing of bacteriocin action of cell cultures and single cells allows direct determination of the mechanism of pore formation and pore properties: its size, permeability, selectivity to various ions, potential dependency, molecule charge, etc. providing information for development of new strategies for enhancement or inhibition of bacteriocin action. A general view of the obtained data gives information about the mechanisms of bacteriocin-induced injury in target cells and provides future facilities in the practice of lactobacilli cultivation.

The most convenient and useful method to study the mechanism of action of pore-forming molecules is the patch-clamp method (Chang D.C. et al., 1983). This method allows determination of pore selectivity, size, permeability and voltage dependence, selection of substances that can modulate the effects of bacteriocin on target cells and direct testing of bacteriocin activity on a variety of defined cell models. The essence of this method is that it allows clamping of cell membrane potential at a given level and examining of current flows through ion channels and pores depending on the test potential applied.

Here we report briefly the results of our

pilot study of newly isolated bacteriocin, produced by *L. delbrueckii* 1043 with unknown mode of action (unpublished data). As it was shown, this substance was proved to contain carbohydrate and lipid moieties. These bacteriocins were tested on single voltage-clamped smooth muscle cells isolated from human jejunum (the upper part of the human intestines). The diluted sample caused a vast increase of the cation efflux through the membranes of tested cells. In fact, the application of bacteriocin 1043 to the cell bath resulted in 700-2100% increase of the outward current amplitudes. The observed effect was voltage dependent, because it was manifested only at potentials positive to +10 mV, while at more negative voltages it was practically inert. At 20°C the cation efflux-enhancing action of lactococcin X started with the latency of 7 min., while at 30°C this latency was diminished to 2 min, which suggests that bacteriocin 1043 incorporates into the native cell membranes, possibly forming voltage-dependent pores, just like rugencin and calcium ionophores do.

The data obtained would help to elaborate new culture media and conditions for bacteriocin producers, which are appropriate for starter culture in milk industry.

3. 2. Anti -viral effect of bacteriocin from *Lactobacillus delbrueckii* 1043

The search for selective antiviral agents has been vigorous in recent years but the need for new antiviral therapies still exists since many of the problems of viral infections treatment, such as generation of viral resistance and undesirable side effects remain.

Influenza continues to be a major cause of high morbidity and significant mortality both for humans and domestic animals. Rimantadine hydrochloride, an analogue of amantadine hydrochloride, the only approved drug so far, has well-documented prophylactic and therapeutic activities in the case of non-complicated influenza A virus infection after oral administration. Rimantadine has no marked antiviral activity or therapeutic effectiveness in established influenza and no specific therapy of proven value currently exists for severe influenza infection. Some adverse effects of rimantadine have also been

reported, and development of viral resistance to rimantadine has been identified as a problem in the use of this drug. Zanamavir, a selective inhibitor of viral neuraminidase, is still under investigation. Obviously the need in effective therapies for influenza virus infection continues to exist.

Different preparations of bacteriocin 1043 were tested for activity on the reproduction of influenza virus A/chicken/Germany, strain Weybridge (H₇N₇) and strain Rostock (H₇N₀ in cell cultures of chicken embryo fibroblasts (CEF). The inhibitory effect was shown to be highly selective and specific. Expression of viral glycoproteins hemagglutinin, neuraminidase and nucleoprotein on the surface of infected cells, virus-induced cytopathic effect, infectious virus yield and hemagglutinin production were all reduced at non-toxic concentrations of the crude preparation (BI). BI did not protect cells from infection, did not affect adsorption and slightly inhibited viral penetration into infected cells. Purification did not enhance the cellular toxicity and increased about 870-fold the virus-inhibitory activity. No inactivating effect on extracellular virus was found. (Serkedjieva et al., 2002).

At the present stage of investigation we cannot relate the effect of the bacteriocin produced by *Lactobacillus delbrueckii* on cell membrane permeability to its virus-inhibitory activity.

The present study supports the concept that naturally occurring products and specifically microbial metabolites in addition to known chemical compounds can be used as alternative antiviral agents. It is interesting to speculate if the observed antiviral activity of the bacteriocin isolated from *Lactobacillus delbrueckii* 1043 could be expressed *in situ*.

CONCLUSION

Mankind has (consciously or unconsciously) exploited Lactic acid bacteria for thousands of years in the production of fermented foods because of their ability to add desirable changes in the taste, flavour and texture and to inhibit pathogenic and spoilage microorganisms. In this aspect bacteriocin's research in the recent years is so extensive. Although many bacteriocins produced by LAB have been shown to be very effective against pathogenic and spoilage micro-

organisms both *in vitro* and *in vivo*, only nisin is currently licensed for food use in a purified form. Several reasons for this exist. Although some bacteriocins may be more effective against some food-borne pathogens than nisin, definite evidence on their effectiveness and stability in foods is still scarce. It is a question what is cheaper to use: bacteriocin-containing food ingredients or to produce the bacteriocin *in situ*: for example, protective cultures of *L. delbrueckii* 1043 and *Str. thermophilus* 81, *L. paracasei* M3 and *Enterococcus faecium* A 2000, natural microflora of Bulgarian yogurt and yellow cheese. However, in several food products the growth of LAB may be undesirable and direct addition of bacteriocins may be a viable alternative. This would require approval by regulatory agencies, although LAB are GRAS organisms and bacteriocins are likely to be present in all natural fermented foods.

The growing consumer demands for natural and minimally processed foods will enhance the research in LAB bacteriocins that will mandate the combination of measures to assure microbial food safety.

References:

- Abee, T. (1995) FEMS Microbiol. Lett. 129, 1-10.
- Abee, T., Klaenhammer, T.R., Letelier, L. (1994) Appl. Environ. Microbiol. 60, 1006-1013.
- Cenatiempo, Y., Berjeaud, J., Biet, F., Fremaux, C., Hechard, Y. and Robichon, D. (1996). Lait, 76-169-177.
- Chang, D.C., Tasaki, L., Adelman, W.J., Leuchtag, H.R. (Eds.) (1983). Plenum Press, NY & London.
- Christensen, B., Fink, J., Merrifield, R.B., Manzerall, D. (1988). Proc. Natl. Acad. Sci., USA 85: 5072-5076.
- Cilano, L., Bossi, M.G. and Carini, S. (1990) Microbiol.-Alim.-Nutr. 8: 21-30.
- Delley, M., Mollet, B. and Hottinger, H. (1990). Appl. Environ. Microbiol. 6, 1967-1970.
- Devriese, L.A., Pot, B., Collins, M.D. (1993). J. Appl. Bacteriol. Nov 5, 3999-408
- Dolin, R., Reichman, R.C., Madora, H.P., Maynard, R. and Linton, P.N. (1982), *New Engl. J. Med.* 307, 580-584.
- Giraffa, G. (1995) Food Microbiol. 12, 291-299.
- Giraffa, G., Bossi, M.G. and Fornasari, E. (1989). Microbiol.- Alim.- Nutr. 7: 139-143.
- Gonzales, C.F., and Kunka (1987). Appl. Environ. Microbiol., 53, 2534-2538
- Gonzalez, B., Area, P., Mayo, B. and Suarez, J. (1994) Appl. Environ. Microbiol. 6:2158-2163.
- Harold, R.J.L, Harold, R.M.L, (1986) J. Gen. Microbiol. Jan 132, 213-9.

- Harris, L., Daeschel, M., Stiles, M. and Klaenhammer, T. (1989) *J. Food Prot.*, 52,6, 3784-3787.
- Hayden, F.G. (1997), *J. Infect. Dis.*, 176, Suppl. 1, 56-61.
- Hayden, F.G. and Couch, R.B. (1992). *Rev. Med. Virol.* 2, 89-96.
- Hechard, Y., Derijart, B., Letellier, F. and Cenatiempo, Y. (1993) *J. Gen. Microbiol.*, 138, 2725-2731.
- Herrmann, J.E., West, K., Bruns, M. and Ennis F.A. (1990). *J. Infect. Dis.* 161, 180-184.
- Holzapfel, W.H., Geisen, R. and Schillinger, U. (1995). *Int. J. Food Microbiol.*, 24, 343-362.
- Ivanova, I., Kabadjova, P., Pantev, A., Danova, S. and X. Dousset (2000). *Biocatalysis 2000. Vestnik Moskovskogo Universiteta, Khimia*, vol. 41, No. 6, Suppl., p. 47 - 53.
- Ivanova, I., Miteva, V., Stefanova, Ts., Pantev, A., Budakov, J., Danova, S., Moncheva, P., Nikolova, I.; Dousset, X., Boyaval, P., (1998). *Journal of Food Microbiology*, 42:147-158.
- Jacks, R., Tagg, J. and Ray, B. (1995). *Microbiol. Rev.* 59,2, 171-200.
- Jimenez-Dias, R., Rios-Sanchez, R., Desmazeaud, M., Ruiz-Barba, G. and Piard, G. (1993). *Appl. Environ. Microbiol.*, 59,1416-1424.
- Joerger, M.C. and Klaenhammer, T.R. (1986). *Journal of Bacteriology* 167, 439-446.
- Klaenhammer, T. et al. *Antonie van Leuvenhook* 82: 29-58, (2002) ed. Kluwer Acad. Publishers
- Kanatani, K., Oshimura, M. and Sano, K. (1995). *Appl. Environ. Microbiol.*, 1061-1067.
- Klaenhammer, T.R. (1993). *FEMS Microbiol. Rev.*, 12, 39 - 86.
- Kordel, M., Sahl, H.G. (1986). *FEMS Microbiol. Lett.*, 34: 139-144.
- Maftan, A., Renault, D., Vignoles, C, Hechard, Y., Bressolier, P., Ratinaud, M.H., Cenatiempo, Y., Julien, R., 1993. *J. Bacteriol.* 175, 3232-3235.
- Marciset, O., Mollet, B. (1993). *FEMS Microbiol. Rev.* 12: 129.
- Martinez, B., Suarez, J.E., and Rodriguez, A., (1996). *Microbiol. UK* 142, pp. 2392-2398.
- Miteva, V., Ivanova, I., Budakov, I., Pantev, A., Stefanova, Tz., Danova, S., Moncheva, P., Dousset, X. and Boyaval, P. (1998). *Journal of Applied Bacteriology*, 85: 603-614.
- Miteva, V., Stefanova, Tz. Budakov, L., Ivanova, I., Mitev, W., Gancheva, A. and Ljubenov, M. (1998). Characterization of bacteriocins, produced by strains from traditional Bulgarian dairy products. *Syst. Appl. Microbiol.*
- Montville, T.J., Bruno, M.E., (1994). *Int. J. Food Microbiol.* 24, 53-74.
- Muriana, P. M. and Klaenhammer, T. (1991). *Appl. Environ. Microbiol.* 57: 114-121.
- Nes, I., Dzung Bao Diep, Haverstein, L.S., Brurberg, M.B., Eijsink, V., & Holo, H. (1996). In *Proceedings of the Fifth Symposium on Lactic Acid Bacteria: Genetics, Metabolism and Applications*. Veldhoven, The Netherlands, 8-12 September 1996, Ed. by G. Venema, J.H.J. Huis in't Veld and Hugenholtz, p. 113 -128.
- Nettles, C.G. and Barefoot, S.F. (1993). *Journal of Food Protection*, 4, 338-356.
- Neviani, E., Giraffa, G., Carminati, D., (1997). *J. Food Prot.* 60, 732-738.
- O'Riordan, I.C., Fitzgerald, Giv, (1998). *J. Appl. Microbiol.* Jul 85, 103-114.
- Piard J., Delorme, F., Giraffa, G., Commissaire, J., Desmazeaud M. (1990). *Neth. Milk Dairy J.* 44, 143-158.
- Piard, J. and Desmazeaud, M. (1992). *Le Lait* 72, 113-142.
- Piard, J.C., Delorme, F., Giraffa, G., Commissaire, J. and Desmazeaud, M. (1990). *Neth. Milk Dairy J.* 44: 143-158.
- Pilloud, N. and Mollet, B. (1990). *Systematic and Applied Microbiology* 13, 345-349.
- Rammelsberg, M. and Radler, F. (1990). *Journal of Applied Bacteriology* 69, 177 -184.
- Schved, P., Lalazar, A., Hennis, Y. and Juven, B. (1993). *J. Appl. Bacteriol.* 74, 67-77.
- Skytta, E., Haikara, A. and Mattila - Sandholm, T. (1993). *J. Appl. Bacteriol.* 74: 134-142.
- Stefanova, Tz., Miteva, V., Ivanova, I., Budakov, I., Gancheva, A., Ljubenov, M., Moncheva, P. and Danova, S. (1996). *The Netherlands, Abs. V Symp. LAB Genetics, Metabolism and Applications*, C60.
- Toba, T., Yoshioka, E. and Takatoshi, I. (1991). *Lett. Appl. Microbiol.* 12: 43-45.
- Upreti, G.C., and Hinsdill, R.D. (1973). *Antimicrobial Agents and Chemotherapy* 4, 487 - 497.
- Van Belkum, M., Haiema, B., Jeeninga, R., Kok, G. and Venema, G. (1991). *Appl. Environ. Microbiol.*, 57, 492-498.
- Van Voris, L.P., Betts, R.F., Hayden, F.G., Christmas, W.A. and Douglas, R.G., Jr. (1981). *J. Am. Med. Assoc.* 245, 1128-1131.
- Vaughan, E. E., Daly, C. and Fitzgerald, G.F. (1992). *J. Appl. Bacteriol.* 73: 299-308.
- Vignolo, G.M., Sudani, F., Holgado, A. P. and Oliver, G. (1993). *J. Appl. Bacteriol.* 75: 344-349.
- Villani, F., Pepe, O., Mauriello, G., Salzano, G., Moschetti, G. and Coppola, S. (1995). *J. Food Microbiol.* 25, 179-190.
- Ward, D.J. and Somkuti, G.A. (1995). *Appl. Microbiol. Biotechnol.*, 43, 330-335.
- Winkowski, K., Bruno, M.E. Monville, T.J., (1994). *Appl. Environ. Microbiol.* Nov. 60, 11, 4186-4188.
- Winkowski, K., Ludescher, R.D., Montville, T.J., (1996). *Appl. Environ. Microbiol.* 62, 323-327.
- Yang, R., Johnson, M. and Ray, B. (1992). *Applied and Environmental Microbiology* 58, 3355-3359.



BULGARIAN ADDED VALUE TO ERA

POINT L-BULGARIA Ltd.

National Winner of the Innovation Award, 2004.

Petar Petrov, Manager of **POINT L-BULGARIA Ltd.**

1000 Sofia, 18 Budapesta Str.

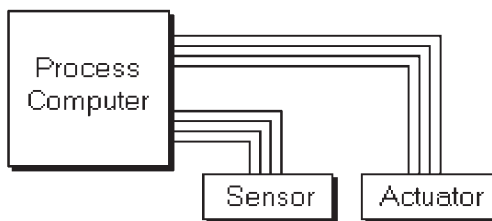
Phone: +359 2 9818555, +359 2 9808483, fax: +359 2 9815718, e-mail: pointl@pointl.com

The scope of activity of **POINT L-BULGARIA** is to develop and to deploy industrial process control systems.

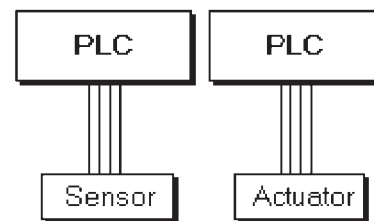
The new open, decentralized, portable, distributed system developed by the company is

based on the LonWorks technology, the Structured Analysis and Design Technique (SADT) method and the contact-less position pick-up of the controlled valves (patented by the company).

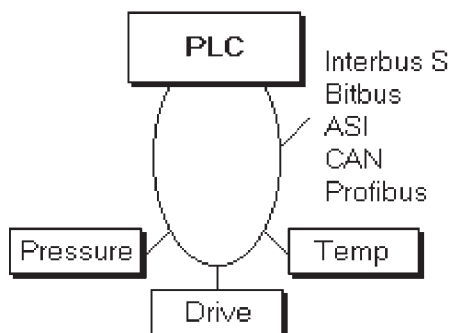
1st Generation



2nd Generation

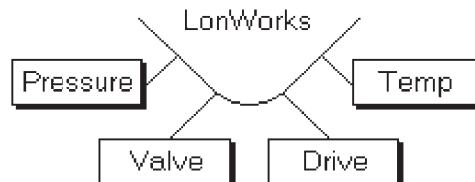


3rd Generation



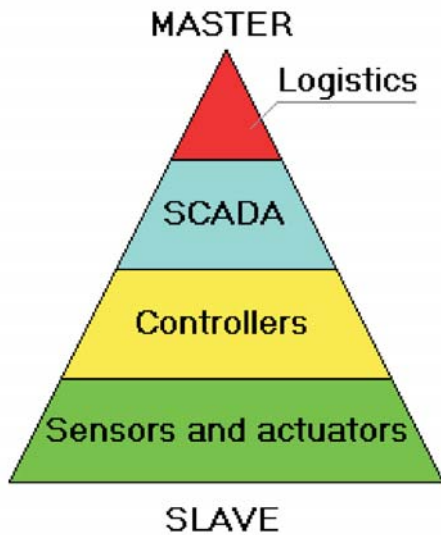
Simplified Wiring
Central Intelligence
Fixed Topology

4th Generation



Simplified Wiring
Distributed Intelligence
Flexible Topology

Description of the Most Substantial Differences between the Existing and the New System



Existing Systems

The existing systems employ the principle of distribution of process control tasks at different levels of the centralizing pyramid.

Logic tasks are solved at the uppermost level.

A SCADA system of operators' panels and a part of the control algorithms are situated at a lower level.

The PLC and other types of controllers executing a part of the control algorithms are situated at an even lower level.

Intelligent actuators and sensors are located at the lowest level.

The inter-level control is based on the master-slave principle.

The technical, software and communications tools at each separate level are of different types and mutually incompatible..

The New System

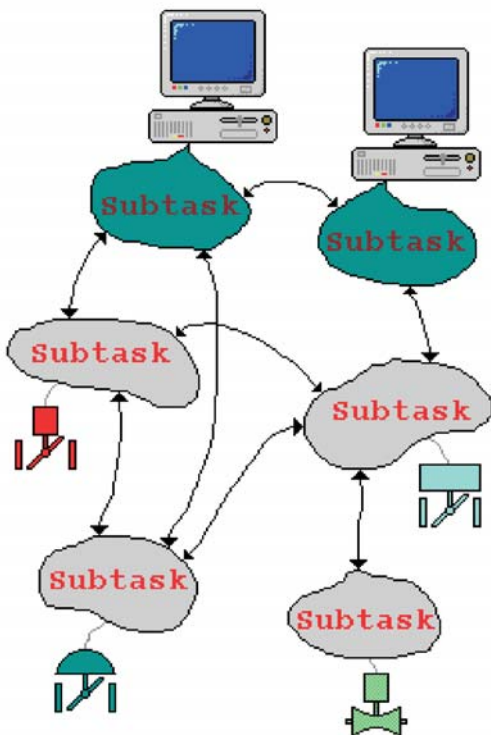
The system is characterized by the reduction of the levels of the pyramid to a single level concept.

Logistic tasks are executed by MS Windows based SCADA systems and intelligent devices which are connected into the network. All they have equal rights in the network (Master is the network).

The POINT L hardware and software products are object-oriented, distributed and decentralized.

The control algorithm is divided into separate objects imbedded in the intelligent modules produced by POINT L and PCs.

The objects (up to 32000) communicate via LonWorks industrial network. Each object can access the whole information. The inclusion of an additional element does not introduce changes into the existing system.



Advantages of the New Distributed, Decentralized, Modular Process Control System

Increased Process Control Reliability. Enhanced Reliability of Control.

The similarity between a living organism and this type of automation systems is much deeper, than the previous systems. Most of the vital organs of the living organisms are most often multiple or duplicated.

Thus for instance a caterpillar may lose a tentacle without losing any of its ability to move.

The new process control system continues its operation even after the SCADA control fails. The system preserves most of its functions even if one or several modules fail. The system continues operation in case of micro-breakdowns of power supply from the point reached immediately before.

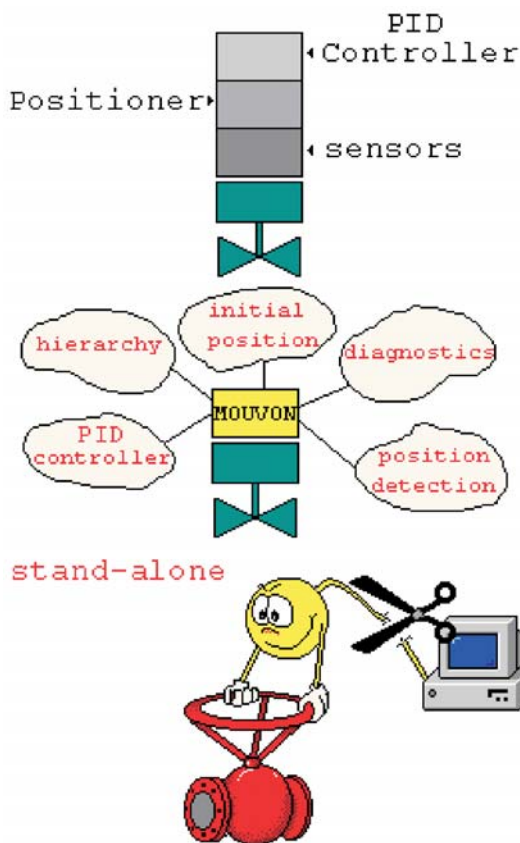


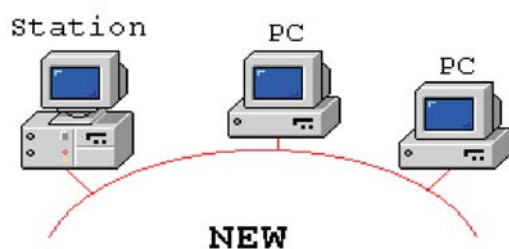
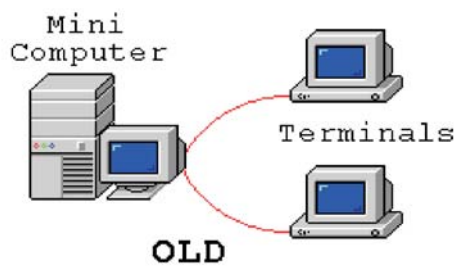
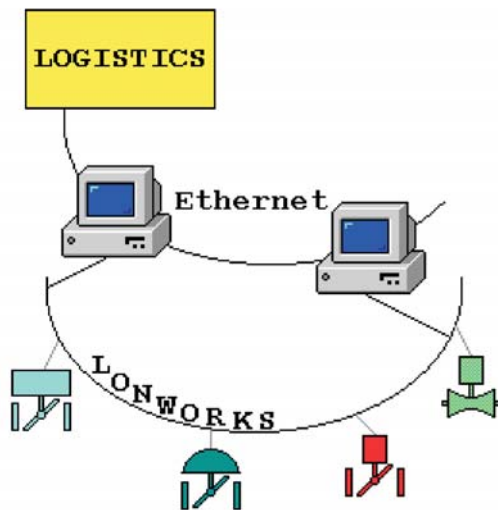
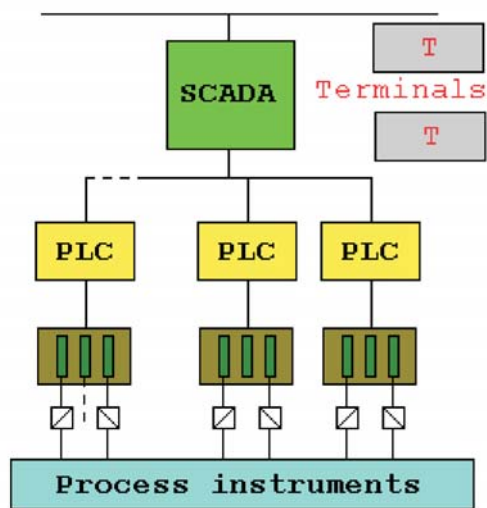
Technology Improvement, Cost, Reliability and Functional Characteristics.

A single intelligent device is now sufficient to execute a simple task, which previously required a whole set of instruments to be performed. This leads to a significant cost reduction.

The device's in-built intelligence makes it possible to eliminate all mechanical connections to the actuator. Thus, the reliability of the module is enhanced.

The enhanced functional characteristics of the intelligent positioning devices make it possible to detect the characteristics of the actuator, to provide for a higher control accuracy, to increase the useful life of valves, to issue alarm signals in case of an imminent accident and to execute control tasks according to a present algorithm.





System Unification

All automation project managers and sub-contractors will be relieved by the increased work and materials efficiency, which will result from the application of the new system. These are the major effects from the application:

- No PLCs are used;
- No positioning devices, controllers and signal transducers are used;
- No control boxes are necessary;
- No communication protocols need to be programmed;
- No monitoring and diagnostics interface for the performance of the actuators is programmed;
- The initialization of various modes for different units is no longer programmed;
- There is no need to purchase different software packages for the various operation systems;
- No separate manuals for different hardware and software components are necessary any longer;
- It is no longer necessary to keep a large inventory of spare parts in stock;
- No new cables are necessary to be laid out for each new specific information or command.
- You are able with four types of intelligent modules to perform any automation task.
- Network topology is free.

Less Pressure on the Supervisory Functions of the SCADA Systems.

Easier Access to Investments.

The visualization, analysis, emulation, set-up and debugging of the basic and the optional functions of the intelligent modules are provided with their own interface.

The elimination of these control and visualization tasks from the SCADA systems simplifies almost by half their operation.

The distributed object-oriented systems allow for the separation of the control tasks into several components.

The process description starts with a functional analysis (SANDRA - CASE Designer). Thus, a complete match between the task and the process algorithm may be achieved. This complies with the ISO requirements for software products.

The clarity of the SADT method allows for a more comprehensive advance knowledge of the process.

The object-oriented approach to the solution of various automation problems makes it possible to develop the whole project in an abstract form and to practically commission only a part of the whole system. Thus the investor may be fully aware of the volume of the whole investment. The multiple automation problems may be reduced to separate stages depending on the specific needs. The clients should not worry any more about the disruption of the production process, as is the usual practice with the options for extending and changing the automation system that existed so far.

Software and Hardware Products of POINT L:

- SANDRA - a Computer-Aided Systems Engineering (CASE) Designer, based on the Structured Analysis and Design Technique (SADT) Method. The product SANDRA is a powerful modern means of analysis, comprehensive description, design and testing of the functional performance of systems, which tracks the causal relationship of all functions, from the general case to a particular case and vice versa. The product automatically generates a program code, which is executed by an interpreter built in the modules MOUVON, manufactured by the company. This interconnection secures the full compliance between the specifications (the particular task) and the implementation of the project. The product allows validation of the applications in accordance with the international standards of quality control, and provides a scenario for their testing.

- QUANTAMAGNUM LM - a software package for designing, installing, and maintaining multi-vendor, open, interoperable LonWorks control networks;

- CREON - a complete process control package (SCADA system).

- MOUVON - a full range of intelligent process control devices (Intelligent electric and pneumatic actuators' controllers, analog and digital I/O), based on the LonWorks Technology; Gateways (LonTalk-ModBus, YorkTalk, CarrierDataLink, etc.). The intelligent valve controllers, de-

veloped by the company, can be build in/to the electric or pneumatic actuators.

The control functions are performed on the basis of contact-less position pick-up. The modules identify the type of the actuators, detect their dynamic characteristics as well as the dynamic characteristics of the controlled valves (forces, end positions, etc.). This scheme of control ensures high precision in positioning (0.5%), considerably increases the life of actuators, and allows complete diagnosis over the industrial network.

Market applications:

Chemical Industry (Drug Production, Biotechnology, Cosmetics, Refineries), Power Generation, Water Treatment and Distribution, Metallurgy (Kilns, Furnaces), Mining, Flow Control, etc.

Realized Projects:

Aventis-Pharma (France), Shell-Refinery (France), Kremikovtzy Metallurgical Company (Bulgaria), Maritza-East Power Plant (Bulgaria), Biovet (Bulgaria), El-Prom-Elin (Bulgaria), etc.

European RTD projects in which the Company is taking part:

- Multi-channel measurement and control system based on resonant piezoelectric crystal sensors ("Competitive and Sustainable Growth", 5th Framework Programme, 2002-2005)

- A Novel Laser-Inkjet Hybrid Printing Technology for Additive Printed, High Resolution, Mass Customized Conductive Copper Tracks - FLEXTRONIC (CRAFT, 6th Framework Programme, 2004-2006)

A Novel Hybrid Regenerating Filter for Improving Air Quality by Safely Destroying Biologically Active Airborne Particulates in AgriFood Production Operations - VOLTAIR (CRAFT, 6th Framework Programme, 2005-2007).

Awarded prizes:

- Gold medal Winner at the International Technical Fair (Plovdiv), 2000;
- National Winner of the European Competition EUROWORDS, 2002;
- National Winner of the Innovation Award, 2004.

ELTA-R - TRADITIONS, PRESENT AND FUTURE IN THE BUILDING OF COMMUNICATION SYSTEMS AND NETWORKS

Holder of the National "Innovative Enterprise of the Year 2005" award

Atanas Chenkin*, president of "ELTA-R Chenkin & Co."

1309, Sofia, 2 Kukush Str.

Phone: +359 2 8122900, Fax: +359 2 8211380, e-mail: office@elta.bg

The ELTA-R Company is a winner in the 2005 National Innovative Enterprise Competition, organized by the "Applied Research and Communications" Fund, together with the Ministry of Economy and Energy and the Mission of the World Bank in Bulgaria, under the patronage of The President of the Republic of Bulgaria Mr. Georgi Parvanov.

Mr. Atanas Chenkin, the president of the company, considers that encouragement of innovations must become a major priority of the country's policy, so it will be impossible to achieve a fast national prosperity without that.

In connection with this, the whole activity of ELTA-R from its establishment in 1990 till the present moment is subordinated to development by innovations.

The main area of the company's activities is the development, design, production, engineering and trade of products of the communication industry, setting up of "turn key" projects with further maintenance, both within a guarantee and out of guarantee period. The production list includes a wide range of products of the communication industry – office, private and local / transit ISDN digital telephone exchanges, portable appliances, specialised telephone systems and appliances in compliance with the technical requirements of the Ministry of Defence, Ministry of Interior and other organisations. The company has implemented Quality Management Systems according to ISO 9001:2000 and AQAP 2110

standards. A lot of awards have been received from national and international events. The company maintains active relations with universities and research institutes. The company has won competitions and has also worked on projects, which are co-financed by national and European funds.

The ELTA-R's experience in the area of creation and implementation of new knowledge.

Sixteen years have passed since the moment when it became possible in Bulgaria to register private trade associations able to accomplish free economic activity.

The euphoria connected with the democratic changes in the society has passed away and there arose the need of creation of an orderly organisation and a strategy for reforming all the sectors in the economy and social life. The limited local market, the disturbed technological connections, the lost global market positions, the leak of highly qualified experts abroad and the worsen state of the education system as a whole, caused big difficulties for investments in the field of information and communication technologies.

The collision with the international competition and the lack of experience led many of the small and medium-sized companies established in the country to their bankrupt or slowed down their development.

ELTA-R is one of the few companies, which stood up the to challenges of the time and fi-

* Eng. Atanas Chenkin – President and Chief Executive Officer of the "ELTA-R Chenkin & Co." company. He was born in 1955. He graduated from the Technical University of Sofia in 1980 in specialty "Computing technology". Till 1990 he worked in the Telecommunications Industry Institute as a research associate and a head of department. In 1990, together with his colleagues from the same institute, he established "ELTA-R" company. Atanas Chenkin is a member of the Managing committee of the Telecommunications Association. He is a vice-president of the International Academy of Telecommunications Quality, registered in Moscow.



The President of ELTA-R Mr. Atanas Chenkin (on the right) receives the "Innovative Enterprise of the Year 2005" award from the Chairman of the State Agency for Information Technologies and Telecommunications Mr. Plamen Vachkov.



ELTA-R – holder of the national "Innovative Enterprise of the Year 2005" award.

nally succeeded in keeping the traditions of the Bulgarian communication industry on the global market.

Many of the small and medium-sized companies meet serious difficulties in performing innovation activities, in planning and management of innovation projects and in marketing of new products and services. It is quite different with ELTA-R Company, which applies an innovation approach in technological aspect as well as in the field of management and marketing. The key objectives that the company management aims at are as follows:

- Understanding and forecasting of the future needs of the clients on various markets;
- A full use of the knowledge and capabilities of the highly qualified experts in the company in satisfying these needs;
- Transforming of the created and acquired knowledge into particular products, services and solutions;
- Extended collaboration with other companies and institutions in performing the maintenance (repair works and servicing);

- Placing the new solutions on the market;
- Ensuring high quality of the solutions and servicing them for their full life cycle.

The management of the company succeeded in drawing in and keeping of some of the best experts in Bulgaria in the field of communications. Extended collaboration with technical universities helped in drawing in young and prominent engineers, which have already developed themselves as experts in the company.

The participation in international projects and collaboration with leading companies in the field of high technologies brought to acquiring a "know-how" and invaluable experience, which have been effectively used in the development of the products of the company.

An efficient quality management system was used in compliance with the international standards.

High working reliability of the manufactured equipment of the ELTA type is an important reason for the extension of the market positions and is one of the main advantages of the

company in the area of company's operation.

Steady and consistent work in this direction enabled the election of the President of the company Mr. Chenkin for the position of Vice President of the International Academy of Quality in Communications (MKKT), registered in Moscow.

An innovative approach is used also in working with the clients— subscribers and telecommunication operators. The experts of the company are continuously in touch with them, performing consultations and studying particular environments in rural regions in Bulgaria, Russian Federation, former Soviet republics, developing countries in Africa. Each project is different and has its own specific features as geographical region, topology of the network, localization and allocation of the population, technical condition of the equipment. The number of settlements having no telephone posts is enormous. The population in undeveloped regions needs an accessible universal telephone service at a low price. On the other hand, the telephone operators need facilities to build a telephone network according to the demands and financial resources available, in order to transform the losing telephone networks into profitable ones by lowering the expenses for installation and operation, increasing the traffic and introducing new services.

ELTA-R Company is a winner in the competition "Innovative Bulgarian Enterprise for the Year 2005" with its **"Complex Solution for Building of a Digital Telecommunication Network in Rural and Mountain Regions Using the ELTA-type Equipment"**.

Purpose of the Complex solution

Rural regions are characterized as having a low level of development of industry, low density of subscribers and long transmission and subscriber lines. During the extension of the subscriber network, the requirements of the clients must be satisfied for economy and up-to-date services and the same level of services must be provided as in the cities – a high quality digital transmission of voice and data, including Internet.

ELTA-R Company has developed a strategy for making up-to-date and stage-by-stage

upgrading of certain regions on a digital platform, using a wide range of devices of the ELTA type, which leads to the possibility of building a complete digital telecommunication system including switching, subscriber access, transmission, centralized exploitation and maintenance. The modular approach used for building the systems, allows a great variety in the proposed solutions and flexibility in the design, a stage-by-stage approach in the building and the following extension of the capacity and the provided services, depending on the clients' demands.

The complex approach applied by ELTA-R complies with the needs of various telecom operators for the successful solution of a great variety of problems.

The solution is oriented to a big market in the countries that have regions with low density of population and allocated in vast hilly and plain to mountain neighbourhoods. Business relationships have been established with operators from Bulgaria, Moldova, Ukraine, Russia, Armenia, Kazakhstan, Azerbaijan and some Arabic and African countries where ELTA-R has built great in number facilities and performs a preliminary certification.

The modular architecture is developed using various in capacity and design units, mentioned in the corresponding design, according to the particular conditions on site.

At the present moment, ELTA-R Company offers to the market an economical set of equipment, which provides the ability for the telecommunication operators to digitalize and develop the rural telephone networks in an effective way.

This becomes possible, because on the early development stage of the equipment, the specific features and great amount of problems that take place at this level of the telecommunication network have been considered. The above process can be adjusted, considering the necessity of a stage-by-stage approach according to the particular plan and financial resources of every single operator.

The marketing strategy of the company includes not just selling certain equipment, but offering complex solutions and technologies for upgrading the rural networks while studying the



2, Kukush Street
1309 Sofia, Bulgaria
tel.: (+3592) 8122 900
fax: (+3592) 8211 380
e-mail: office@elta.bg
<http://www.elta.bg>



Complex Telecommunication Solutions

present conditions in terms of organisation and development of the local network in advance, together with the local operator.

The ELTA set of equipment developed and supplied to the market includes telephone exchanges (switches) of various types and capacities, remote subscriber modules with local internal traffic, small concentrators with a capacity from 8 to 32 subscribers, equipment for multiplexing of the subscriber lines including the ones embedded in every single switch.

In addition, uninterruptible power supply units, distribution frame equipment – external or embedded in the working space of every single switching module, with the corresponding recoverable protection from powerful external impacts, are included in the complex solution.

Each of the devices can operate independently or in a system.

By using the corresponding software, the complex solution allows building of distributed telecommunication networks with different topologies and structures.

The complex solution is an open system for integration and inclusion of new interfaces and protocols for signalling, in order to provide the most up-to-date services to the users.

Thus, for instance, especially considering the conditions in the Russian Federation, particular solutions were offered and realized, which, after being implemented, provided for a fast increase of the operators' incomes and improved the condition of the telephone network and the quality of the subscribers' services, such as:

1. Use of remote modules and concentrators with a low capacity. They are maintenance-free, with a remote power supply and can also operate through overhead lines which makes them a solution with no alternative in providing telephone services at settlements, neighbourhoods and farms consisting of 5 to 50 houses.

By using these devices, directly loaded are the telephone exchanges that have a capacity not in operation and, to a great extent, the problem with the applicants having subscribed for a telephone service is quickly solved.

2. Using transmission facilities with a low capacity in the rural network.

This solution makes it possible to immedi-

ately take out of service the old-fashioned analogous transmission systems operating through long transmission lines, including overhead lines.

The adoption of this solution instantly improves the quality of connections, increases the throughput of the transmission lines, and eliminates the expenses for maintenance and the necessity of regeneration stations.

3. Application of a technology for planned extension of the present coordinate-type automatic telephone exchanges by digital equipment, according to the financial resources of each operator.

This approach provides for a stage-by-stage extension of the digital service subscribers capacity and collapsing of the analogous one, up to the complete taking out of service of the old coordinate-type automatic telephone exchanges.

4. Application of a technology for transforming the rural networks into digital ones, not only in a top-down, but also in a bottom-up manner.

This approach provides for an instant rise in the rate of involving digital telephone services in the rural regions. ELTA-R has certain "know-how" in making this aim a reality.

The efficiency of the solutions applied by the company that make use of the equipment developed and manufactured by it is largely attained, in technical aspect, due to:

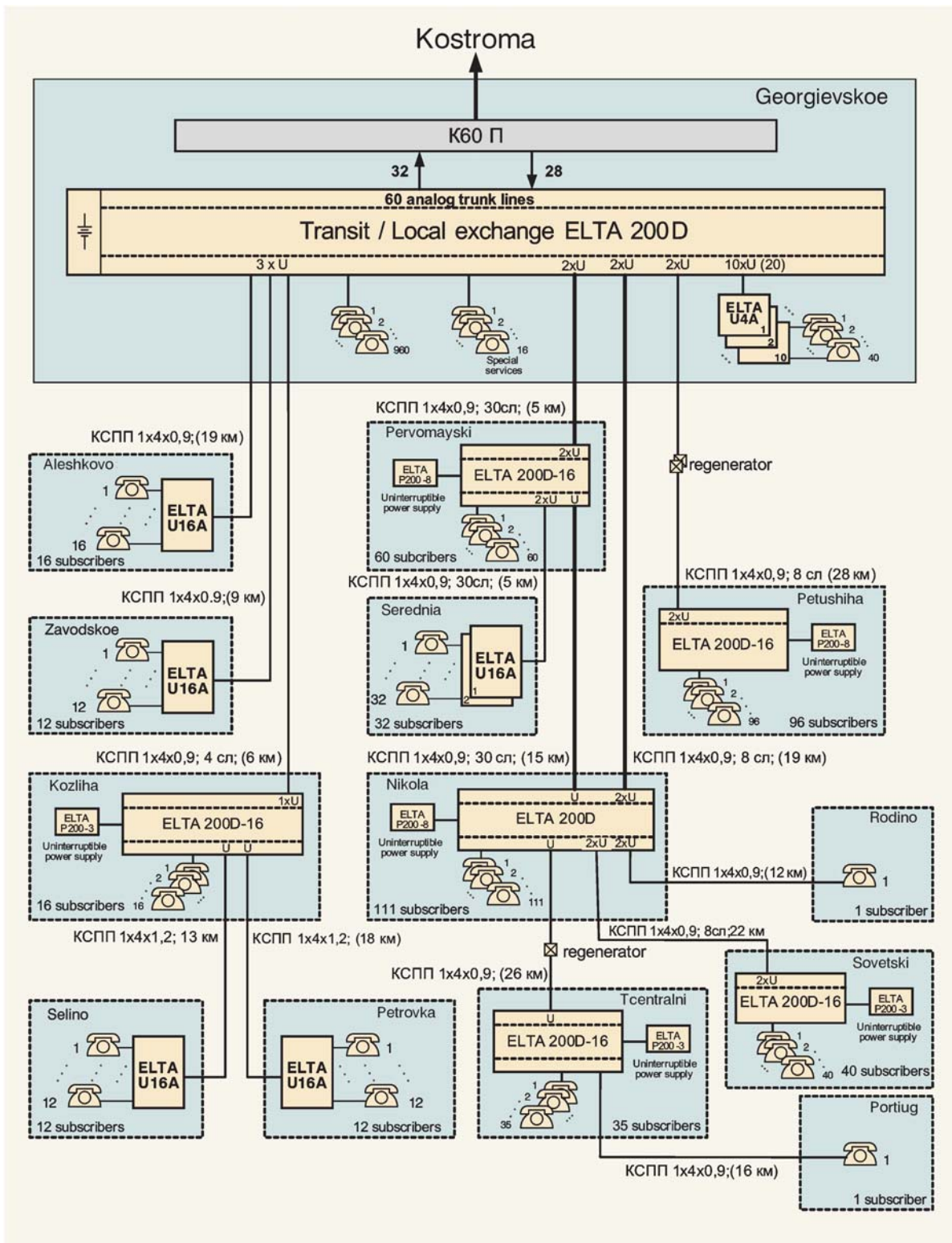
1. A maximum use of the existing cabling for connection of remote subscriber modules and concentrators.

In such a case, all new construction is acceptable only for a cheap (and short, up to 300 m in length) subscriber network.

2. An efficient use of the existing transmission lines by extending their throughput, including increase in the number of channels.

3. An extension of the existing analogous automatic telephone exchanges by digital equipment at a minimum investment costs (building a digital overlay at the end level).

4. A suitable grouping of the endmost automatic telephone exchanges, including building of micro-nodes, to decrease the load over the transmission lines, thus reducing the number of channels to the upper level.



Example structure of Digital telephone network with distributed capacity in Kostroma region, Russian federation

5. An obligatory connection of small villages, neighbourhoods and farms to the telephone network while using the existing subscriber lines, up to the required subscriber density.

6. An obligatory supply of the entire range of information services to the countryside population and to the producers of agricultural goods.

7. An obligatory use of an embedded system for a remote control and monitoring of the equipment, an integrated recoverable protection and a reliable uninterruptible power supply, considering the heavy conditions in the rural regions.

For certain regions in the Russian Federation, after the upgrading of the rural telephone network has been performed, the operators report overall indexes of the efficiency of the solutions of ELTA-R as follows:

- The number of lines per a maintenance employee increases by 65 to 100;
- The expenses by 100 units of investment decreases from 95 to 52 points;
- The profitableness calculated by the net profit has a mean value from 27 to 30%;
- The operational costs have diminished from 2,5 to 3 times;
- The mean period of return of investments is within 2 to 3 years;
- The volume of the intercity and international traffic has increased 2,8 times;

The development of the Complex solution for building a telephone network in rural and mountain regions with a low population rate is not a single act. Depending on the specifics of the given project, the experts from the R&D department of the company develop additional hardware and software modules in order to extend the functional capabilities of the telecommunication system and to add extra services. Thus an increased competitiveness and firmness of positions on the market are achieved.

The development of the set of equipment under the trademark ELTA200D started in 2000. The full choice of functional capabilities was reached within the period 2002 – 2004, after a great

number of tests took place. At the present moment projects are started and funded for extension of the system by integrating equipment and services for radio access, VoIP, WiMax, Internet, etc.

The Complex solution exposes higher technical and economic indexes compared to the other ones on the market; it is covered by a patent and a trademark. Plenty of projects have been commissioned for telecommunication operators in various countries like Bulgaria, Russian Federation, Republic of Moldova, Ukraine, Kazakhstan, Armenia, Azerbaijan, etc.

Conclusion

The innovation strategy that ELTA-R Company follows stimulated by the high competition on the market and by the accelerated development of the information and communication technologies, is distinguished as highly administrative cultured and strictly following the recommendations of the international and Bulgarian standards.

With the help of competent and well-known companies, complex systems for quality management are developed and implemented, covering the overall working cycle of administration, research, document handling and manufacturing.

Successful audits and certificates issued according to ISO9001:200 and AQAP 2110 are an impartial assessment that the products and systems developed and manufactured by ELTA-R Company have high technical and functional indexes, resistant to mechanical and environmental impacts as well as high reliability and competitive price.

Whether the company will succeed in keeping the acquired present positions depends only on its management, proper strategy chosen and extension of the innovation approach.

The impending membership of Bulgaria in the European Union and the expectations that the Bulgarian government will contribute to the support of innovations in the field of high technologies could help this process.



INNOVATION POLICY IN BULGARIA

Olga Racheva

Director "Information Products and Services", NACID



In accordance with the objectives of the Lisbon Program on economic reform of the European Union, widened in Göteborg and improved in Stockholm and Barcelona, the activities of the member states should be directed to the following priority areas: stimulation of competitiveness and entrepreneurship; innovation fostering; providing higher rate of employment, protection of the environment and modernization of the European social model.

The program sets the frame within which the EU member states form their priorities on the basis of their needs of the reform as a part of an all-European initiative. In this way the enlarged European Union will manage to meet challenges of the modern global economy. Active participation of Bulgaria in implementation of economic reforms will help for achievement of long-term economic growth. That is why Lisbon process requires finding out tools for fostering competitive production with future potential for development that can seriously influence the entire restructuring of the economy. It is of particular importance for Bulgaria at the moment when sources for economic growth are sought. Elaboration and consistent application of the technological development and innovation policy is the key instrument for achievement of high competitiveness of Bulgarian economy.

The Innovation strategy of the Republic of Bulgaria (Decision No. 723 of September 8, 2004) was worked out and adopted by the Council of Ministers as the first step in innovative policy development.

During the investigations and analyses made in the course of the Innovation strategy development it was stated that low innovation activity is one of the main problems of Bulgarian companies. The problem with the innovation activity consists in the fact that there should be found instruments for transformation of the

policy of survival into policy of development of enterprises, and that means that actions should be planned in a long-term aspect.

Enterprises should develop dynamically in order to survive in the new competitive environment. The number of companies investing in improvement of production processes, extending personnel's qualifications and improvement of the quality of production and marketing grows constantly.

The main objectives of the Innovation strategy can be grouped in the following trends:

- stimulation of research activity in the industry, reassuring cooperation between research units, universities and companies;
- improvement of innovation financing;
- encouragement of new technologies implementation and increase of the companies' innovation activity;
- stimulating creation of clusters in the sectors traditional for the country.

The strategy will be realized through the following measures:

- Stimulation of innovations and technological development – creation of a National Innovation Fund for support of innovative and technological market-oriented projects;
- Encouragement of young highly qualified specialists employment in small and medium-size enterprises as a precondition for increase of innovative potential of small and medium-size enterprises;
- Creation and/or optimization of Technological centers – working out mechanisms for transformation of some of the existing research institutes into technological centers, as well as building up new ones;
- Optimization of the connection "science – technologies – innovations" – establishing active dialogue between different experts;

- Training in entrepreneurship – popularization and education in entrepreneurial spirit in order to build up effective and competitive small and medium-size business;
- Creation of clusters in Bulgaria – popularization and acquiring best EU practices and supporting creation of clusters;
- Adoption of European indicators for appraisal of the innovative potential of industrial enterprises – creation of a system for assessment of innovative processes in Bulgaria.
- Involvement of investments in the research and development activity – loading the existing research units with orders from external assigners;
- Creation of new and support of the existing technological parks – conditions for development of high-technology production using capacities and experience of the research organizations that won recognition;
- Creation of entrepreneurial centers at higher educational institutions aiming to train the graduates so that they could build up and manage their own companies.

The second step in formation of the innovation policy is establishment by the decision of the Government in 2005 of the National Innovation Fund – the main financial instrument for support of innovative companies and development of competitive enterprises.

Strategic objective of the National Innovation Fund is to increase competitive power of the Bulgarian economy through:

- Stimulation of the market-oriented scientific applied research investigations destined for industry;
- Creation of conditions for private capitals involvement in financing of innovations in conformity with the Innovation strategy of the Republic of Bulgaria and measures for its realization.

The National Innovation Fund is administered by the Executive Agency for Promotion of Small and Medium-size Enterprises (SMEs). Its main task is to support projects that include research and experimental projects aiming at adoption of new manufactures and products

connected with increase of innovative potential of enterprises.

Persons registered according to the Trade Law and working on a project themselves or together with other persons registered according to the Trade Law, higher educational institutions, Bulgarian Academy of Sciences, scientific organizations and collective bodies can apply for subsidy.

The support of enterprises is realized through free financial aid directed to:

- Scientific research/applied projects. These projects are concentrated on technological development of new products, processes and services or on improvement of the existing ones, each offer being a novelty for the Bulgarian market. Each project consists of industrial research and of the so-called pre-market development including the first stages of development. The financed activities are: expenses for labour, materials and consumption, as well as expenditures for sub-suppliers. 25 to 50% of the total project expenses are financed by the Fund. Projects with pre-project studies can get 25% subsidy for the made expenditures. Maximum value of the subsidy is up to 50 000 BGN for projects with realization term up to 1 year. The Technical Council remits the due subsidy on each separate project after acceptance of intermediate and final results.
- Technical economic/pre-project studies investigate the chance for realization of a particular research/applied project. The purpose is to study the technological innovation, economic viability, to estimate technical and economic feasibility of the project. Financed activities on these projects are expenses for labour and sub-suppliers. The Fund finances up to 50% of total expenses on a project.

Annual National Innovation Forum started in 2004. It is organized by “Applied Research and Communications” Foundation (Innovation Relay Center /IRC/ - Bulgaria) together with the Ministry of Economy and Energy and Mission of the World Bank in Sofia, supported by Directorate General “Enterprise” of the European Commission, US International Development Agency, Bulgarian Industrial Association, GIS Transfer Center

Foundation and Bulgarian Academy of Sciences. The aim of the organizers of the forum was to turn it into an open mechanism for benchmarking local innovation knowledge and expertise with the best European and world practice. The main objective of the forum was to stimulate the innovation potential of Bulgarian economy through creation of a national platform for exchange of ideas and cooperation between the government, business community and research organizations. The platform has for its task to improve competitive power of Bulgarian companies by means of broader introduction of new products and technologies and facilitation of business contacts with European partners. National contest for innovative enterprise of the year is organized within the framework of the forum. The aims of the contest are as follows:

- Stimulation of innovation activity of Bulgarian enterprises;
- Popularization of enterprises – participators in the contest and results achieved by them in the innovation field

The WINNER in both of the categories gets a statuette of honour and a diploma. Prize winning enterprises for the year 2005 are:

SMALL ENTERPRISES CATEGORY:

DAISY TECHNOLOGY Ltd.

The company develops and produces digital consumer electronics /digital multimedia cameras, players, adaptors, etc./ It takes part in the contest with two innovations:

- o MP3 players
- o Digital multimedia cameras, being novel on international market and presenting essential part of the company's production and export.

TRAPEN SP

The company performs scientific research, experimental and manufacturing activities in the field of systems for automation of technological processes in the cement and dressing industries and other related branches. It has introduced over 40 systems for management of grinding processes in ball mills. Its development projects are international prize winners in Nu-

remberg – Germany and Brussels – Belgium in 2001. The company takes part in the contest with two microprocessor systems for automation and measuring of loading of different kinds of mills for grinding of cement, ores, coal, etc. in the cement, dressing and other industries, taking about 80% of the company's production and having higher technical-economic parameters than the ones existing on the market.

COATTEX Ltd.

The company performs research and design activity, production and delivery of apparatuses, installations and industrial technological lines for powder coating, enamelling, talcking, metal coating. The firm won gold medals at the International Technical Fair in Plovdiv in 1992, 1994,1996,a diploma of the Patent Office of the Republic of Bulgaria in 1997 and a diploma of "Conrad Adenauer" Foundation – Germany in 2003. It takes part in the contest with its innovation "Apparatus for powder electrostatic coating", model APEN®- 30G1(2).

ANTIPODES Ltd.

The company develops technologies in the field of system architecture and design, databases, works out complex solutions including web, applied and system programming as well as integration of external development products.

It takes part in the contest with two innovations:

- Antipodes Workflow.Cubes™ is the first of its kind system for business process management in Bulgaria, allowing visual description and automation of unspecified in their complexity processes in organizations.
- 3D Spacer™ is a unique in its nature innovative software solution for planning home and office interior, allowing both professionals and amateurs in the sphere of interior design to prepare skilful interior solutions with exclusive technical precision within some minutes. Working on- and off-line, 3D Spacer™ is suitable to be used on web-pages as well as in exhibition halls and shops of furniture manufacturers, interior designers, real estate agencies, etc.

MEDIUM-SIZE ENTERPRISES:

ELTA-R

The company performs development, manufacturing and engineering of a wide range of items of communications industry, including automated telephone exchanges, concentrators, multiplexing systems, peripheral devices and specialized telephone systems. It has more than 7000 built projects in Bulgaria. The company is in close contact with scientific research laboratories, universities and academic organizations in Bulgaria and abroad. It participates in the contest with complex solution for development of digital communication network in sparsely populated regions with ELTA-type equipment. Some of the solutions are protected by patents and trademarks and have higher technical and economic parameters than the ones existing on the market. Innovation is about 60% of the company's sales volume and 100% of its export.

ORGACHIM Jsc

The company manufactures anhydrides, resins, plasticizers and paints. It won 5 gold med-

als at Plovdiv International Fair and a diploma from Interstroy Expo in 2002. It is certified according to ISO 9001-2000 – ISO 14000 and the system for management of healthy and safe labour conditions. It takes part in the contest with series of products for professionals – Deko-professional, used for coatings in open and closed premises.

The products are with higher technical and economic parameters in comparison with the existing ones on the market. The products form 40% of the company's sales volume and 15% of its export.

OPTIX Co.

The company designs and manufactures optical components and assembled units, medical optical devices and products for the military industry. All articles of special production are designed and produced in conformity with the NATO standards. They are certified according to ISO 9001-2000. The company participates in the contest with 13 products including night vision goggles and binoculars, optical sights, etc., which are novel for the Bulgarian market.



MADE IN BULGARIA WITH EUROPEAN SUPPORT

TECHNOLOGY FOR PRODUCTION OF HEAT PIPE BASED ON PROCESS OF PRESSING ONE MATERIAL COMPLEX

Person for Contact: Mr. Angel Milev,

Applied Research and Communications Fund (ARC Fund)

Phone: +359 2 9867887, Fax: +359 2 9801833, Email: angel.milev@online.bg

The developed technology is a result of the fulfillment of a scientific project. New results are used for the mechanical behaviour in the plastic area of certain type of complex materials composed of metal and non metal components as well as results of long-term R&D work on development of machines and technologies for pressing thick- and thin-wall tubes and such with multitude of capillary holes in the Institute of Metal Science of the Bulgarian Academy of Sciences, Department "Plastic Deformation of Metals and Alloys". The institute is interested in collaboration with companies and research centers dealing with HP investigation and production as well as with research institutes in the field of development of new composites and examination of their mechanical behaviour in the area of high plastic deformations.

Heat pipes employ to transfer thermal energy from one point to another by evaporation and condensation of working fluid or coolant. A heat pipe is essentially a passive heat transfer device with an extremely high effective thermal conductivity. The two-phase heat transfer mechanism results in heat transfer capabilities from one hundred to several thousand times that of an equivalent piece of copper. A heat pipe in its simplest configuration is a closed, evacuated cylindrical vessel with internal walls lined with a capillary structure or wick that is saturated with the working fluid. As heat is input into the evaporator, fluid is vaporized, creating a pressure gradient in the pipe. This pressure

gradient forces the vapour to flow along the pipe to a cooler section where it condenses transferring its latent heat of vaporization. Internally, in order to overcome gravitational forces (or because of their absence in the case of space applications) most heat pipes contain a wick structure. The working fluid is then returned to the evaporator by the capillary forces developed in the wick structure.

Innovative Aspects: Unlike the currently available technologies for production of HP where the components of HP (body and wick) are made separately and then assembled, the development of technology by the Bulgarian Institute starts from a complex initial billet which contains in itself different materials and by pressing process simultaneously forms the body and the wick. A bar of tube type is produced containing the body, wick and heat transferring medium with parameters corresponding to finished HP. Pieces of the length of the HP are cut from this bar and for the accomplishment of the final product it is only necessary to install the bottoms and to vacuum it. One of the characteristic features of this new technology is that in the pressing process the heat transferring medium, which could be metal or non metal and is obligatory in solid physical condition, is used as active deforming medium and remains inside the wick after its pressing, thus eliminating the necessity for further operation of its introduction. If the heat transferring medium has no the suitable physical and mechanical properties to be used in

the described manner, other appropriate material is used, which should be taken out of the wick by melting or dissolution. In that case it is necessary for the required operation heat-transferring medium to be additionally led into the tube. The realization of this concept is connected with the use of a know-how technology of pressing where super high deformation rates are realized as well as with new results of examination of the mechanical behaviour of composites in the plastic area.

Main Advantages: The production time is cut down significantly. The production costs are lower than the ones of the known technologies for production of heat pipes. The technology

allows production of heat pipes with big length. When the heat-transferring medium is in solid physical state at room temperature it may be implanted in the process of production of the heat pipe. The technology provides possibility together with the wick structure an arterial one to be also formed at high variety of the design parameters. The application aspect of this concept is combined with the scientific research in the field of the behaviour mechanics of complex composites in the plastic area, which unlike the elastic one is not enough explored. There are results that provide the basis to suggest realization of additional positive effect of the development of knowledge in this field.

NEW TECHNOLOGY FOR DESIGN AND MANUFACTURING OF TECHNOLOGY EQUIPMENT

Person for contact: Mr. Dimitar Ganev,

Applied Research and Communications Fund (ARC Fund)

Phone: +359 2 9867557, Fax: +359 2 9801833, Email: dimitar.ganev@online.bg

A Bulgarian medium-sized company offers a technology for design and manufacturing of technology equipment, including automation of metal cutting machines for production of small-sized builds, programming, trading, solutions for metal cutting machines with CNC (Computer Numerical Control) technology and repairing services and modernization of machines such as machining centres and automatic lathes. The offered technology consists of: technical assistance in erection and start-up of heavy machines tools; design and manufacturing of technology equipment; automation of metal cutting machines for production of small-sized builds; export-import and marketing of new and second-hand tools for metal cutting and metal working machines.

Innovative Aspects:

- Repairing services and modernization of machines such as machining centres, types: MC 032; PB 501.24; automatic lathes, types: CT 161; CP 586; CP 161 etc;
- CNC system integration;
- Innovative solutions and programming of metal cutting machines with CNC technology.

Main Advantages:

- Production of spare parts and consumable materials for geological-prospecting work: cone joints, adapters, nipples, hard-metal core bits, single- and double-wall core barrels, casing pipes, hinged spanners (power tongs), core lifters, swivel heads, elevators, screws, rod bores, drilling string stem
- Production of equipment and spare parts for ore-mining, coal production and the food, wine and tobacco industry: dump-cars, ventilation pipes, band conveyors, temping devices, pasting machines, different kinds of mixing spoons
- Repair of: loading machines, pneumatic engines for loading machines; mine electric carriers 4.5 ARP-2M; drill-hole equipment SKB-4, URB-3AM, 1BA-15B; piston water pumps-11GrB, 120/40, NB-32; asynchronous motors for electric carrier 4.5 ARP, power transformers up to 1000 KVA
- Production of spare parts for loading machines, drill-hole equipment, piston water pumps and spline shafts as well as cylindrical gears to module 12.

A NEW TECHNOLOGY FOR RECYCLING OF THIN AND STRONG, VERY DIRTY LDPE AND LLDPE FILM

Person for contact: Dimitar Ganev,

Applied Research and Communications Fund (ARC Fund)

Phone: +359 2 9867557, Fax: +359 2 9801833, Email: dimitar.ganev@online.bg

A private Bulgarian company established in 1974 offers a technology for recycling of thin and very dirty LLDPE (Linear Low Density Polyethylene) film. In the beginning the company recycled only clean plastic wastes. For the last 5 years now the company has been specializing in recycling of thin and very dirty LDPE (Low Density Polyethylene) and LLDPE waste. The good management of the technology process is the basis of the good results and implemented innovation. Thanks to the experience the company made an efficacious technology for recycling of thin and very dirty LDPE and LLDPE waste mainly

from the agricultural sector. The technology allows overall clean utilization and recycling of the plastic refuse, instead of its burning. The company is interested in joint venture agreement with foreign partners, interested in plastics recycling.

Innovative Aspects: The technology is for recycling of thin and very dirty LDPE and LLDPE film.

Main Advantages:

- The technology is for recycling of thin and very dirty LDPE and LLDPE film.
- Good management of the technology process.

SIMPLIFIED METHODOLOGY FOR MODELLING LADIES' GARMENTS

Person for contact: Ms. Maria Alexandrova,

Applied Research and Communications Fund (ARC Fund)

Phone: +359 2 986 7557, Fax: +359 2 980 1833, Email: maria.alexandrova@online.bg

The method has been developed by a Bulgarian university department active in research and education in the clothing and textile sector. It is applicable in ladies' garment production and concerns the process of modelling drafts of garments designs. The methodology aims to solve the problem of complexity of calculations and drawing in the process of construction of ladies' garments, and also to make them fit better to the body. The methodology is created on the basis of analysis of other methodologies for modelling, knowledge about proportions, form, structure and motions of a lady's body and interaction between components. The dimensions formulas used in the methodology could be adapted according to the various anthropometrical standards. The methodology could be

applied in CAD/CAM systems used for ladies' garments production. Companies from the fashion industry and software firms dealing with CAD systems are sought for technical cooperation, manufacturing agreement with technical assistance, technical co-operation and financing.

Innovative Aspects: Simplified dimensions and geometrical drawing and free additions depending on the silhouette. The methodology is applied for drawing with CAD systems. The use of the methodology decreases the time of modelling.

Main Advantages: The methodology provides simplified geometrical drawing and free additions depending on the silhouette. It is applied for hand modelling and drawing with CAD systems.



EQUAL IN EUROPEAN RESEARCH AREA

BULGARIAN VIPs:

The Executive Director of "Energy Efficient Systems" Ltd.

Assoc. Prof. DIMITAR BAEV, PhD

Phone: +359 2 8464069, e-mail: dbaev@ees-bg.com



Mr. Dimitar Baev graduates his MSc and PhD degrees at the Electrotechnical University in St. Petersburg – Russia, respectively in 1967 and 1973. Since 1980 he is an Associate Professor.

Automation and energy efficiency engineer with over 35 years of experience in the field of industrial automation and information technologies and more than 12 years of experience in the field of energy efficiency, energy planning, training and project development.

His professional domains are: energy management, energy demand forecast analysis and energy balancing, performance measurement and verification, training of energy managers on introduction of advanced energy technologies, industrial energy policy and energy information systems design and implementation, development of investment analyses, financing models and business plans along with feasibility studies for energy efficiency and renewable energy projects, information strategies, awareness campaigns and dissemination of energy technologies including organization of training, workshops, conferences and exhibitions, project management and team leadership.

Dr. Baev has more than 14 years of experience in energy efficiency project implementation in Eastern Europe including technical and economic assessments of investments. Most of the projects he was involved in included training and dissemination (seminars, conferences, study tours). He is the manager of Energy Efficient Systems Ltd. – a com-

pany awarded by the President of the Republic of Bulgaria as innovative company of the year 2004.

Dr. Baev is one of the founders of the Bulgarian Chapter of the Association of Energy Engineers (AEE), being its president from 1998 to 2001. He has been Executive Director of the Bulgarian Chapter of the AEE since 2001.

Due to his long experience in business development of international consulting projects he has an excellent overview on financing energy efficiency, combined with his wide contact network in the USA, Western & Eastern Europe. Dr. Baev speaks very good English and excellent Russian.

The Specific Eastern European and CIS professional experience of Dr. Baev includes the following major projects:

1993: Bulgaria Demand Side Management Assessment, USAID project, Survey Manager of "Survey on the 106 largest industrial electricity consumers". Subcontractor of Hagler Bailly Consulting.

1993-1994: Energy audit and energy efficiency project in Machine Building plant ZMM - Sofia - USAID project. Project Manager

1993-1996: Energy Efficiency Market Development in Bulgaria. USAID project. Support of 10 demonstration industrial energy saving projects performed by AEE – Bulgarian chapter members. National Conference for dissemination of results from the project organization. Subcontractor of Hagler Bailly Consulting

1996-1997: Energy audit and efficiency saving project in the Municipality Hospitals in Gabrovo Dr. "T. Venkova". Project Administrator. Subcontractor of Electrotek Concepts Inc. Demonstration USAID project. The project was awarded as the best inter-

national project by the AEE.

1998-2002: Energy efficiency cost sharing project in the Municipality Hospital "St. Anna" in Varna - USAID supported project. Energy audit, energy saving equipment installation, performance monitoring and evaluation. Project Manager. Partner of Electrotek Concepts Inc.

1988: Multinational PHARE Sub-project "Diversification of Gas Supply in Albania, Bosnia-Herzegovina, Bulgaria, FYR Macedonia and Rumania. Consultant to Bechtel Ltd.

1999-2000: Comprehensive Program for energy savings in the social institutions of the Ministry of Labor and Social Policy. Project manager. Project of the Regional Environmental Center for Central and Eastern Europe.

1999-2000: Energy Audit in the Municipality Hospital in Gorna Orayahovitza. EcoLinks Project. Project Manager. Partner of Electrotek Concepts Inc.

1998 – 2002: Energy efficiency project in Bulgarian Telecom, including: Energy survey on 1600 production units of the Bulgarian Telecom and Energy Saving program. 15 pilot projects implementation. Development of procedure for energy audits and energy managers training. The project was awarded as one of the best 50 in "Energy Globe'2001" forum, Austria, Wels. Project Manager.

1999: "UkrESCO development" TASIC Project. Engineer - Consultant to Bechtel Ltd., Ukraine. Training of the personnel and customers. 11 preliminary energy audits. Selection of portable energy measuring equipment. Measurement and verification procedure development.

1999 – 2001: Energy Efficiency Project in "Pirinsko Pivo" Brewery, Blagoevgrad. Project Manager. Energy audit, energy saving equipment delivery and installation, training, performance monitoring and verification. Partner of Electrotek Concepts Inc. The first project in the world using DCA financing scheme, according to the MEEP.

2001-2002: Development and Implementation of Energy Monitoring and Control System in "Pirinsko Pivo" Brewery, Carlsberg - Bulgaria. Project Manager.

2000-2001: Promotion of Energy Efficiency Measures in "Chugunoleene" JSC, Ihtiman. EcoLinks Project. Project Manager. Partner of EnergoPro, Kiev.

2002-2003: Business plan for implementation of Energy Efficiency Measures in "Chugunoleene" JSC, Ihtiman. Follow-on EcoLinks Project. Project Manager.

2000-2001: Eco/Energy Audit in "Elprom-Elin" JSC, Kubrat. EcoLinks Project. Project Manager. Partner of PA Consulting, USA.

2001-2002: Development and Implementation of Energy Monitoring and Control System in "Elprom-Elin" JSC, Kubrat. Project Manager.

2002-2003: Preparing Bankable Documents for Financing of Energy Saving Measures in "Elprom-Elin" JSC, Kubrat. Follow-on EcoLinks Project. Project Manager.

2002: Energy Audit in "Danone", Sofia. Project Manager.

2003: Energy Audit in "Damianitza" Vinery. Sub-contractor of Electrotek Concepts Inc.

2003: Energy Audit in "Razgrad" Vinery. Sub-contractor of Electrotek Concepts Inc.

2002-2003: Development of Long Term Energy Efficiency Program in "Zebra" JSC, Novi Iskar. EcoLinks Proj. Project Manager. Partner of "Domani" Co, USA.

2003-2004: Development and Implementation of Energy Monitoring and Control System in "Zebra" JSC, Project Manager.

2003-2004: Development and Implementation of Energy Monitoring and Control System in "Shumensko pivo" Carlsberg. Project Manager.

2004: Energy Audit in "Kraft", Svoge. Project Manager.

2004: Pipeline of projects for Bulgarian EE Fund, World Bank and MEER project

2005: Energy Audit in "STM", Veliko Tarnovo. Project Manager.

2005: Energy Audit in "Kraft", Kostinbrod. Project Manager.

2005: Development and Implementation of Energy Monitoring and Control System in "STM", Veliko Tarnovo. Project Manager

2006: Energy audits in United Milk Company, "Pobeda" chocolate plant in Burgas

2006: Development and Implementation of Energy Monitoring and Control System in "Lomsko pivo" Brewery, Project Manager

During his long professional career Mr. Baev has been a consultant to a lot of institutions and organizations, including EBRD; BECHTEL; Nexant Ltd.; HP Consulting; Hagler Bailly Consulting; Electrotek Concepts; EnCons Services, Inc.

Mr. Dimitar Baev has more than 40 publications in the fields of energy efficiency, automation, and information technologies.

AWARDS

PRIZE WINNERS OF THE NATIONAL CONTEST "YOUNG TALENTS- 2006" ANNOUNCED

The 8th annual National Contest "Young Talents", organized by the Ministry of Education and Science and the National Science Fund, announced the awarded projects and the contest winners for the year 2006.

President of this year's Award Nominations Jury was Prof. Sava Grozdev from the Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences. Prof. Grozdev pointed out the serious national traditions in discovering, support, encouraging and promotion of young talents in all fields of the human knowledge and science. According to him the Bulgarian school system offers the necessary theoretical base, followed by functional training and technological competencies, yet nowadays grows the importance of the creativity competency. The serious levels of the contestants' projects and the winners of the National Contest are a serious proof of these traditions.

Sonya HADZHIEVA from the *Sofia High School of Mathematics* won the **first prize** for a second consecutive year. She won't be able to attend the European Contest for Young Scientists for a second time according to the regulations. Bulgaria will be presented at the 2006 EU Contest in Sweden by the **second prize** winner Boian MIHAILOV from the *Science and Mathematics School- Vidin* with his Virtual Chemistry Laboratory for 7th Grade, as well as by the **third prize** winners from the *National Science and Mathematics School- Vidin*, Georgi DIANKOV and Dimitar ILIEV with their Methods for measuring the index of refraction and digital investigation of two-dimensional gravity waves. Detailed information about the contest regulations and awards can be found at the Internet site of the "Young Talents" National Contest, <http://young.nsfb.net/>



ARTICLES

RECENT PUBLICATIONS OF BULGARIAN SCIENTISTS

1.Title: **Problems of Small- and Medium-sized Enterprises Development in R. Bulgaria.**

Authors: Manoilova, Temenuga¹ *tmanoilova@hotmail.com*

Source: International Journal of Entrepreneurship & Innovation Management; Vol. 6, 1/2, (2006), 7-7,

Document Type: Article

Author Affiliations: ¹Energoproekt - JSC, 51, James Boucher Blvd. Sofia 1407, Bulgaria.

ISSN: 1368-275X

2.Title: **Breaking the Family and Friends' Circle: Predictors of External Financing Usage among Men and Women Entrepreneurs in a Transitional Economy.**

Authors: Manolova, Tatiana S.¹ *tmanolova@bentley.edu*; Manev, Ivan M.²; Carter, Nancy M.³; Gyoshev, Bojidar S.⁴

Source: Venture Capital; Vol. 8, 2, (2006 Apr.), 109-132, 3 charts, 1 diagram

Document Type: Article

Author Affiliations: ¹Bentley College, Waltham, Massachusetts, USA;

²University of Maine, Maine Business School, Maine, USA;

³Catalyst, Inc., New York, USA;

⁴International Business School, Botevgrad, Bulgaria

ISSN: 1369-1066

3.Title: **Internationalization Process, SMEs and Transitional Economies: a Four-country Perspective.**

Authors: Lloyd-Reason, Lester¹ *L.Lloyd-Reason@apu.ac.uk*

Damyantov, Atanas² *adamyantov@uni-svishtov.bg*

Nicolescu, Ovidiu³ *manager@pcnet.ro*

Wall, Stuart¹ *s.d.wall@apu.ac.uk*

Source: International Journal of Entrepreneurship & Innovation Management; Vol. 5, 3/4, (2005), 1-1,

Document Type: Article

Author Affiliations: ¹Centre for International Business Research, Ashcroft International Business School, Anglia Polytechnic University, East Road, Cambridge CB1 1PT, UK.

²D. Tsenov Academy of Economics, 2, Em. Chakarov Str, Svishtov 5250, Bulgaria.

³International Management and Marketing Institute, 6, Anghel Saligny, Sector 5, Bucharest, Romania

ISSN: 1368-275X

4.Title: **Price Markups and Returns to Scale in Imperfect Markets: Bulgaria and Hungary**

Authors: Dobrinsky, Rumen¹ *rumen.dobrinsky@unece.org*

Körösi, Gábor^{2,3} *korosi@econ.core.hu*

Markov, Nikolay ⁴ *nmarkov@mail.ibn.bg*
 Halpern, László ^{2,5,3,6} *halpern@econ.core.hu*
Source: Journal of Comparative Economics; Vol. 34,1, (2006 Mar.), 92-110,
Document Type: Article
Author Affiliations: ¹UN Economic Commission for Europe, Palais des Nations,
 CH-1211 Geneva, Switzerland
²Institute of Economics, Hungarian Academy of Sciences, Budaörsi út 45,
 112 Budapest, Hungary
³CEU
⁴Centre for Economic and Strategic Research, kompl. Geo Milev bl. 46
 vh. A ap. 3; Sofia 1113, Bulgaria
⁵CEPR
⁶WDI
ISSN: 0147-5967

5.Title: **Anticipation Effects of Technological Progress on Capital Accumulation:
 a Vintage Capital Approach.**
Authors: Feichtinger, Gustav¹Hart¹, Richard F.²Kort, Peter M.^{3,4} *kort@uvt.nl*; Veliov,
 Vladimir M.^{1,5}
Source: Journal of Economic Theory; Vol. 126, 1, (2006 Jan.), 143-164,
Document Type: Article
Author Affiliations: ¹Institute of Mathematical Methods in Economics, Vienna University of
 Technology, Argentinierstrasse 8, A-1040 Vienna, Austria
²Department of Business Studies, University of Vienna, Bruennerstrasse 72, A-
 1210 Vienna, Austria.
³Department of Econometrics and Operations Research and CentER, Tilburg
 University, P.O. Box 90153, NL-5000 LE Tilburg, The Netherlands.
⁴Department of Economics, University of Antwerp, Prinsstraat 13,
 2000 Antwerp 1, Belgium.
⁵Institute of Mathematics and Informatics, Bulgarian Academy of Sciences,
 BG-1113 Sofia, Bulgaria.
ISSN: 0022-0531

6.Title: **Monopolistic Wages or Efficient Contracts?**
Authors: Dimova, Ralitzá¹
Source: Economics of Transition; Vol. 14, 2 ,(2006 Jul.), 321-347,
Document Type: Article
Author Affiliations: ¹Faculty of Economics and Finance, Brunel University, Uxbridge,
 Middlesex UB8 3PH, UK.
ISSN: 0967-0750

7.Title: **Comment: The Growth of Alternative Dispute Resolution in Bulgaria.**
Authors: Chernev, Silvy¹
Source: European Business Law Review; Vol. 17, 2, (2006), 423-424,
Document Type: Article
Author Affiliations: ¹President, Arbitration Court, Chamber of Commerce and Industry, Sofia
ISSN: 0959-6941

.....

DEFENDED DISSERTATIONS ON THE SUBJECT: "SMALL AND MEDIUM-SIZED ENTERPRISES AND INNOVATIVE PRODUCTS"

"SIRENA" Database - NACID

Author Parashkevova, Loretta Petrova
Degree PhD
Title A Model of Behavior of Small and Medium-sized Enterprises Serving Big Enterprises
Affiliated Organization Varna Free University, complex "Chajka", 9007 Varna
Abstract In the dissertation, based on research of experience worldwide and analysis of the state and development trends of small and medium-sized enterprises /SMEs/ in globalisation, possibilities for development of SMEs - sub-contractors of big companies are suggested, depending on the degree of commitment, durability of contacts and type of production. The author definition of SMEs and classification of SMEs - sub-contractors are suggested. The engagements of small and big enterprises are distinguished. The suggested model of behaviour of SMEs gives a theoretical and practical decision of this problem for optimisation of indicators at the stages of realization of marketing and innovation policy of SMEs. The following methods are used in the research-method of systematic analysis, induction and deduction methods, methods of comparison, statistical and mathematical methods.
Library Central Research and Technical Library

.....

Author Todorov, Kiril Assenov
Degree DSc
Title Strategic Management in Small and Medium-sized Enterprises /Theory and Practice/
Affiliated Organization University of National and World Economy, Studentski grad, 1100 Sofia
Abstract Main objective- to investigate theoretical-methodological and methodical aspects of strategic management in small and medium-sized enterprises and to evaluate parameters of its practical implementation, thus to formulate possible alternatives for decisions at different levels in this area. Research methods- System and system-contingency approaches, inductive and deductive approaches. The particular research analysis and synthesis are achieved through systems of methods including; statistical methods /incl. data processing with SPSS/, questionnaire surveys, comparative methods, analogy methods, heuristic /expert/ methods, case study methods as well as combination between them. Results- Finding of new facts and development of existing theories and concepts; practical approbation of the research theses; practical recommendations in the field of strategic management in small and medium-sized enterprises /SMEs/ are worked out. Fields of application- in pursue of government policy for SMEs support and promotion; in real business; in conducting research in the field.
Library Central Research and Technical Library

.....

Author Lazarov, Rumen Nikolaev
Degree PhD
Title The Innovative Activity of the Companies of the Transitional Period /after the model of Pleven, V. Tarnovo, Lovech and Gabrovo districts/
Affiliated Organization Tsenov Academy of Economy, 5250 Svishtov
Abstract On the background of critically analyzed endogenous and exogenous environment of the enterprises as well as by application of methods for observing and investigating of innovation based on the Oslo Manual, the intensity of influence of 71 factors in 59 industrial enterprises on regional level were assessed by the method of direct interview. Interdependence between size, forms of proprietorship and ways of acquiring, levels of export intensity and innovation activity are investigated. Innovation activity in the enterprises is assessed. The investigation confirms the thesis that under conditions of transition the innovation of enterprises is at a low level, but it is not their inherent feature. Innovation is a functional variable facing different barriers both in endogenous and exogenous milieu of enterprises. Concurrently, there are favourable factors, too. Among them are real property rights in the newly organized enterprises as well as in the joint ventures, demonstrating higher innovative activity.
Library Central Research and Technical Library



E V E N T S

12 – 16 September 2006

XVI National Scientific Symposium with
International Participation

“Metrology and Metrology Assurance 2006”

Department “Electrical Measurements”,
Department “Precision Engineering and
Measuring Instruments”,

TU - Sofia;

State Agency of Metrology and Technical
Surveillance,

Union of Metrologists in Bulgaria and
Kozloduy Nuclear Power Plant
Sozopol- Bulgaria

Address:

Department of Electrical Measurements,
TU - Sofia,

8, Kl. Ohridski Blvd.,

Sofia 1000, Bulgaria

Phone: +359 2 965 2366,

Fax: +359 2 9652896, +359 2 9652438

www.metrology-bg.org,

e-mail: tzvetkov@tu-sofia.bg

13 – 15 September 2006

Twelfth International Conference on Artificial
Intelligence:

“Methodology, Systems, Applications - AI, People and the Web”

Varna, Bulgaria

Address:

Company for International Meetings Ltd.

18, Christo Belchev Str.,

Sofia 1000, Bulgaria

Phone: +359 2 988 80 35, 980 89 61

Fax: +359 2 980 60 74,

e-mail: cim@cim-pco.org

15 – 16 September 2006

International Conference

“Education, Science, Economy and Technologies in the Global World”

“Prof. Dr. Assen Zlatarov” University,
Faculty of Social Sciences
Bourgas, Bulgaria

Address:

“Prof. Dr Assen Zlatarov” University
1, “Prof Yakimov” Str.,
Faculty of Social Sciences

For the International Conference

8010 Bourgas, Bulgaria

Phone: +359 56 858 117,

Fax: +359 56 860 019,

e-mail: fon@btu.bg

17 – 19 September 2006

VII International Conference

“Advanced Productional Operations - AMO’06”

Faculty of Machine Technology – Technical
University of Sofia
Sozopol, Bulgaria

Address:

Technical University - Sofia, FMT, Block 3

8, “St. Kl. Ohridski” Blvd.,

1000 Sofia, Bulgaria

Phone: 003592 9652508, Fax: 003592 9652536,

e-mail: jtp@tu-sofia.bg;

18 – 20 September 2006

“Scientific Conference EMF ‘2006”

Faculty of Power Engineering and Power
Machines, TU-Sofia

St. Constantine and Elena Resort, Varna

Address:

1000 Sofia, Bulgaria

Phone/Fax: +359 2 965 32 94,

e-mail: petrov@tu.sofia.bg

18 – 22 September 2006

The Fourteenth International School on
Quantum Electronics

"Laser Physics and Applications"

Institute of Electronics, BAS
Sunny Beach, Bulgaria.

Address:

Dr. Todor Arabadzhiev, Institute of Electronics,
BAS
72, Tzarigradsko Chaussee Blvd.
1784 Sofia, Bulgaria
Phone: +359 2 7144 653,
Fax: +359 2 975 3201
e-mail: schoolqe@ie.bas.bg

22 – 24 September 2006

20th International Conference

**"Systems for Automation of Engineering
and Research, SAER' 2006"**

Technical University of Sofia
St. Constantine Resort,
Varna, Bulgaria

Address:

SAER International Conference,
P.O. Box 33,1756 Sofia, Bulgaria
e-mail: saer@tu-sofia.bg

2 – 4 October 2006

11th International Conference on

**"Mechanics and Technology of Composite
Materials"**

House of Scientists of the Bulgarian Academy
of Sciences
Sofia, Bulgaria

Address:

Central Laboratory of Physico-Chemical
Mechanics, BAS
Acad. G. Bonchev Str., Block 1,
1113 Sofia, BULGARIA
www.clphchm.bas.bg/en/Instructions.html

3 – 6 October 2006

International Conferences

**"John Atanasov Celebration Days
Automatics and Informatics' 2006"**

Union of Automatics and Informatics,
Sofia, Bulgaria

Address:

Union of Automatics and Informatics
108 Rakovski Str., Room 415
Sofia 1000, Bulgaria
Phone:/ Fax: +3592 987 61 69
e-mail: sai@infotel.bg,
www.sai.infotel.bg

19 – 21 October 2006

International Conference on

**"Communications, Electromagnetics and
Medical Applications" (CEMA'06)**

Faculty of Communication Technologies
of TU - Sofia, Bulgaria
Sofia, Bulgaria

Address:

Faculty of Communication Technique and
Technologies
TU - Sofia, 8, Kliment Ohridsky Str.,
1756 Sofia, Bulgaria
Phone: +359 2 9652278,
Fax: +3592 9741360
e-mail: dcd@tu-sofia.bg,
www.tu-sofia.bg/fktt/cema06/

27 – 28 October 2006

Scientific Conference with International
Participation

**"Food Science Engineering and
Technologies- 2006"**

University of Food Technologies -Plovdiv

Address:

University of Food Technologies (UFT)-Plovdiv
26 Maritza Blvd.,
4002 Plovdiv, Bulgaria
e-mail: nk_uht@abv.bg

Events

.....