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ASSISTANCE TO PACKAGING CENTRE

DP/TUR/81/013

TURKEY,

Technical report: Final evaluation of the shelf-life project*

Prepared for the Government of Turkey
by the United Nations Industrial Development Organization,
acting as Executing Agency for the
United Nations Development Programme

Based on the work of Mr. Iván Varsányi,
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United Nations Industrial Development Organization
Vienna

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ABSTRACT

I.

A. Title and number of the project

The title of the project is "Assistance to Packaging Centre", and its number is DP/TUR/81/013/11-01/31.7.E. The duration of the project is 3 years, it started in the first half of 1983.

B. Objective and duration of the activity

The objective of the activity was to introduce and to show the practical methods and the theoretical aspects of shelf-life determination of food, giving lectures at the "International Packaging Symposium (II)" and carrying out seminar for food manufacturers about the same topic, and to make a final evaluation of the shelf-life project, completing the mission of expert between 14 October 1985 and 14 February 1986.

The duration of the activity was 15 days, and it started on 21 of June.

C. Main conclusions and recommendations

Summarizing the experiences of present mission it may be stated that the food industry is one of the most important and progressive sector of the Turkish national economy. Therefore to keep the quantity and quality of food from the production till the consumption it needs an effective co-operation between the packaging and the food industries. The modern packaging techniques need a higher quantity, quality and assortment - first of all - from the plastics and laminated materials. Following the requirements of markets it is recommended to extend the activity of the Packaging Centre for research and development, including design works with a good co-operation with the food and the packaging industry. To establish the scientific base of packaging knowledges it is also recommended to improve the training programme of chemical engineering in the University to the field of packaging techniques.

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III. INTRODUCTION

A. Background

The Packaging Centre began operating in 1982, under the project TUR/75/056. The second phase of the project started in 1983 and it will be completed at the end of 1986. During that period packaging material and consumer and transit testing equipment was installed, fellowships were realized by the members of staff in foreign countries and two experts assisted in the field of food packaging and training. The expert activity was started on 21 June 1986 and was completed on 5 July 1986.

B. Objectives of the activity

The objective of the activity being reported on is identical with the duties stipulated in the job description. The expert gave two lectures at the "International Packaging Symposium (II)", participated in the panel session for "Development suggestions in the field of packaging". The expert carried out a seminar for food manufacturers to introduce the methods and the basic considerations of the shelf-life determination of food. For the finalization of the shelf-life project he evaluated them, and prepared recommendations for the further activities with special regards to the field of food packaging.

IV. RECOMMENDATIONS

A. For development of Turkish packaging and food Industry

1. Increase the production the assortment and the quality of polymer base packaging materials in Turkey, regarding to the hygenic aspects of food packaging.
2. Develop the production and the assortment of the laminated packaging materials in Turkish packaging industry for the combination of plastic + plastic, plastic + paper, and plastic + alufoil.
3. Create the possibilities to use the up-to-date packaging systems (e.g. aseptic line) in the Turkish food industry to produce high nutritional content food.
4. Elaborate or adapt packaging and preserving systems in the food industry for the energy saving technologies, as e.g. the sterilizable pouches.
5. Apply vacuum and inert gas packaging technologies for high aroma content food and for some meat products.
6. Start the production of the bag-in-box systems for juices and beverages in the packaging industry.
7. Investigate the possibilities of microwave proof packaging material production in the packaging industry.

8. Launch a research project for biological value saving and energy saving combined preservation methods using the gamma-irradiation with a special reference to the packaging materials.
9. Launch a research project to determine the effects of transportation and loading for the fresh fruits and vegetables with a special regard to the cushioning problems.
10. Launch a research project to extend the shelf-life of fresh fruits and vegetables with suitable packaging, regarding to the respiration, transpiration behaviour of that biologic materials.
11. In order to realize the recommended research projects it is necessary to build up the research and development base of packaging and food industry, both on university and on institutional level.

B. For development of Packaging Centre

1. Extend the activity of the Packaging Centre: for testing of plastic and laminated packaging materials; for investigating the interactions between the packed food and wrapped materials; for optimizing the transport packages of fresh fruits and vegetables; and for packaging design.
2. Improve the scientific and practical base of the Packaging Centre and supplement the staff with specialists from the field of plastics and laminated materials.
3. Increase the activity of the Packaging Centre in the field of public relations and information services.
4. The Packaging Centre should obtain instruments for light transmission measurements, for microbiology testing, for analyses the penetrated materials in packages by HPLC (High Performance Liquid Chromatography) and TLC (Thin-Layer Chromatography).
5. The name of the "Packaging Laboratory" of Turkish Standards Institution changed to "Packaging Research, Development and Testing Center" in April 1986. Regarding to the duties increased and the activities extended which are implied by the new name of the institute, it is recommended to consider the development of the Centre and to increase the number of the staff with specialists for research and development works, including the design, too.

C. For further improvement of symposiums and seminars organized by Packaging Centre

1. It would be very useful to organize international symposium in the future, but it would be necessary to make more efforts to reach the international level inviting more speakers from other countries, and - using the reputation of speakers - to publicize more for foreign participants, too. It would be helpful to join to the international scientific and technical life.
2. Carry out seminars periodically for three-four days in the future, inviting excellent scientists and industrial experts as speakers both from Turkey and foreign countries. It would give information for the participants to know the latest results both on the national and on the international level.
3. Improve the information activities for the symposium and seminar, sending information to the international journals and magazines and to the relevant foreigner institutions.

The original objectives of the activities of the expert were not revised and the target were attained.

V. ACTIVITIES AND OUTPUTS

A. Main duties

The main duties of the job description and the objectives of the activity being reported are as follows:

1. Participation in the events of the "International Packaging Symposium (II)".
2. Carry out a seminar for food manufacturers about the determination of shelf-life of food.
3. Final evaluation of the shelf-life project, and to give recommendation to the Government for further actions.

B. Technical activities

The technical activities carried out accordingly to the job description were as follows:

1. Participation in the events of Symposium

a. Lectures given

An "International Packaging Symposium (II)" was organized by the Turkish Standards Institution Packaging Research, Development and Testing Center, on 23-24 June 1986, in Ankara, Turkey. The place of the Symposium was the Conference Hall of the Turkish Standards Institutions.

At the Symposium 17 lectures were given by 18 authors, 4 of them were from other countries (Cyprus, France, UNIDO). The Symposium worked in 6 sessions and in a panel meeting. The topics of lectures covered the main interesting problems of food packaging by the side of packaging material producers, consumers, and researchers. The lectures were followed by discussions.

The Symposium had 185 participants from 89 institutions. The number of foreigner was 5 from 6 different countries and international organizations (Cyprus, France, Saudi Arabia, UNIDO). One lecturer from Iran did not arrive. The list of participants is tabulated in Annex 1, and the list of lectures and lecturers is shown in Annex 2.

The interest of audience was quiet high, some of the lectures were followed with lively discussions. The organization of the Symposium was on international level. The lectures and the discussions were translated by syncrone-interpretators very well, from/tc Turkish and English.

During the 1st Session as the second speaker the expert summarized the main trends of packaging over the world ("Packaging in the world" Annex 3.) After the lecture three questions were asked from the audience about the importance of plastic packaging materials and about the application of metal containers in the future.

The second lecture was given as second speaker in the 4th Session about the "Principles of shelf-life determination of packaged foods". (Annex 4). A very lively discussion built up after the lecture, eight of the participants asked fourteen questions about the correlations between the shelf-life and the packaging materials, and the packaging systems (e.g. vacuum packaging).

Both of the lectures were illustrated by 6 and 10 slides, respectively.

The second lecture was well supplemented by the next speaker, Ms.N. Temur (Turkish Standards Institutions Packaging Research, Development and Testing Centre), who showed the practical aspects of the shelf-life determination method, applying the experiences earned by vacuum-packed sauseges during the previous mission of the expert (in 14 October - 14 February 1986).

b. Panel discussion

As the closing event of the Symposium a panel discussion took place about "Development suggestions in the field of packaging". The chairman of panel was the representative of the State Planning Organization, and the members came from universities, from steel, and glass factories, from food, and oil, and packaging industries, from packaging testing and research institutes, together 16 national specialists, and 1 international expert.

The members of the panel were given the opportunity to express their opinion about the above mentioned topic during two rounds. All the speakers emphasized the importance of packaging with a special regard to the demands of export-markets. It was also concluded that the co-operation between researchers, producers and consumers need more efforts. It was also pointed out, that in order to educate packaging specialists university level training is needed.

c. Packaging Exhibition

Completing the work of the Symposium a packaging exhibition was opened between 23-28 June in the entrance hall and the basement of the Conference Hall of the Turkish Standards Institutions. 19 Turkish firms were present, showing their newest products, most of them were on polymer base. There were also paper, printing and glass factories present exhibiting their latest products.

The area of exhibition was cca. 150 m², the estimated number of visitors was 400. Groups were not organized for the exhibition, but approximately 60 institutions - most from the district of Ankara - were invited.

The exhibition offered a good chance both for the producers and for the consumers to exchange their experiences about the application of packaging materials.

2. Seminar

To finalize and to complete the mission of expert between October 1985 and February 1986, a seminar was organized by the counterpart institution to disseminate the methods of shelf-life determinations for the food manufacturers, consumers and researchers.

The invitations and the programme of this seminar were prepared by the Turkish Standards Institution Packaging Research, Development and Testing Centre. The seminar was held in the Training Section of Packaging Centre on 1st of July, 1986. (The programme of seminar is in Annex 6).

The programme of seminar had four parts: (i) lecture by the expert; (ii) visit of the Packaging Centre's laboratories with a special regard to the practical aspects of shelf-life determination; (iii) a lecture by the counterpart about the shelf-life determination of vacuum packed sausages, which was carried out during the previous mission of the expert; and (iv) an informal discussion about the theoretical and practical aspects of shelf-life determination with a special reference to the packaging materials.

31 Participants from 14 institutions joined the work of seminar. The list of participants is in Annex 7.

The last part of the seminar was the discussion. The questions there were covered the different aspects of shelf-life determination of food with special reference to the problems of the packaging optimization. Some of the questions were from the field of legislation, referring to the relevant paragraphs of food law, connecting with the rules of labelling.

Summarizing the results of the seminar it can be stated that it was very useful. The informal discussion gave possibilities to ask about the details of the object and to learn the problems in wider range.

Therefore it would be very recommended to follow the practice just started now and to extend the activities on this field in the future. The seminar also offers a good chance to create connections with the industries for the Packaging Centre.

3. Final evaluation of the shelf-life project

a. Shelf-life determination and packaging test

A complete investigation programme was elaborated by the expert for shelf-life determination and for packaging test during the previous mission of the expert. This programme was applied to a packed food model selected by the counterpart institution. An evaluation programme was also elaborated which is suitable for computerization both for shelf-life determinations and for packaging tests.

On the base of the investigation programme prepared the shelf-life of the food model was determined for three different storage temperatures, it gave the results as follows: the shelf-life of vacuum packed sausage is 22 days at 0°C; 19 days at 5°C; and 9 days at 25°C storage temperature, respectively.

According to the results of package tests, it may be concluded that the mechanical properties of packaging material changed significantly during the storage periods, but other properties did not change consequently. The carbon dioxide gas permeability and the air permeability tests were not carried out during the last period because the instrument did not work properly. Therefore it would be necessary to pay attention to improved equipment service.

The mathematical computer programme was not elaborated by the adequate department selected of the University of Ankara, therefore it was not possible to control the applicability of the computer programme. But the recommendations prepared earlier give suitable informations for the computerization of the evaluation of measurements.

b. Training

One of the main target of the previous expert mission was to hand over his knowledges and experiences about the shelf-life investigations to the counterpart team. Regarding to the lectures at the Symposium and at the seminar it can be stated that they understood the principles of shelf-life determination and it seems they can apply their knowledges to an other food products. However, the last half year the Packaging Centre did not deal with this matter.

c. Activities during the Symposium and Seminar

The International Packaging Symposium and the followed seminar organized by the authorities gave a good opportunity to introduce the methods of shelf-life determination with special reference to the problems of labelling and food-law. The factories, universities and other institutions attending the events promised to clarify the problems of shelf-life determination in a wide range.

The interest of the audience was significantly high not only just during the discussions but also during the breakes of events- which created further possibilities for discussions.

C. Recommendations for further actions

Regarding to the lectures, discussions, panel meeting, and the unofficial discussions during the events of the Symposium and the seminar it can be stated that - according to the earlier experiences of the expert - increase of food exports is the basic interest of Turkey. Therefore to increase the proportion of packed food - including the fresh fruits and vegetables - and for that purpose to increase the production (quantity/ quality) and the assortment of the packaging materials (plastics, laminated and metallic materials) is the fundament of the progress.

A modern packaging industry can also create possibilities for the energy and material saving technologies and helps to increase the profitable production both for the home and for the export market. Therefore the modernization of food technologies (aseptic technologies, combined preservation methods, modern sterilizing equipment, etc) is an important step to the national income improvement. The new packaging techniques (Sterilizable pouches, vacuum and inert gas barriers, boil-in-bag packaging, bag-in-box system, etc) help to increase the shelf-life of food, and to reorganize the systems of distribution. The expectable result is - beside higher profits - better supply of higher nutritive food.

To reach the above mentioned main targets it is necessary to establish the scientific base of the development. Therefore it is recommended to elaborate an educational programme on university level, and - following the international practices - to establish a department of packaging engineering for education of students, who have B.S. degree in chemical engineering. The packaging engineering courses would take two years, and it should involve the science of chemistry, physical-chemistry, unit operation, automatization, and design. After the two years courses the students should receive a M.S. degree.

On the fundament of a M.S. degree the systematic research work for Ph.D. degree on university level can be started.

Parallel to that it is recommended to launch the research works, according to the national targets.

Concerning the Packaging Centre it is necessary to work together with international experts in the beginning for a longer period (approx. 1-2 years) to extend the practice of national staff in the research and development works. As far as the change of name of Packaging Laboratory of Turkish Standards Institution to "Packaging Research, Development and Testing Center", implies a wider responsibility it is recommended to change the structure of the Centre, extending their activities to the fields of research and development and to increase the number of staff with appropriate specialists for the main areas of activity and to complete the instrumentation of the Centre for analytical devices, first of all for plastics and laminated materials. It is further recommended to improve the relationship with the industries using the possibilities of information services.

Regarding the necessity of increased food export, it is highly recommended to harmonize the research work in the field of food and packaging. Without co-operation between the food and packaging industry - including the development of packaging machinery - countable results and profits can not be expected.

VI. CONCLUSIONS

The "International Packaging Symposium (II)" offered good possibilities for discussions and to survey the present situation in the field of packaging, regarding to the requests of consumers. It is recommended to follow this practice. The organization of Symposium was at an international standard.

The participation of international experts should be further increased. Therefore it would be necessary to increase the public relation efforts using the international journals and magazines.

The discussions after the lectures and during the panel showed the interest of audience and it helps to determine the tasks of the future.

The organization of seminars is a very good idea. It would be considering to extend the duration of them to three-four days, inviting more national and foreign speakers, according to the topic selected.

Evaluating the shelf-life project it may be concluded that the elaborated test plan for shelf-life determination was completed for the model food selected. The prepared investigation programme is applicable to other food, and it gives the possibility to design, to carry-out, and to evaluate shelf-life tests. Since during the last half year problems did not arise relating to the shelf-life determination in the counterpart institution it may be concluded that the project for shelf-life determination was successfully completed.

Summarizing the conclusions it can be stated that the shelf-life project was completed by the expert receiving the chance to introduce the theoretical and practical methods and aspects of shelf-life determination to a great number of audience during the Symposium and the Seminar. The discussions with authorities and specialists inspired the expert to give additional recommendations to the Turkish Government for further actions.

VII. ACKNOWLEDGEMENT

I wish to express my deep appreciation to the authorities of Turkish Standards Institution for the invitation and for the co-operation; to the UNDP officials in Ankara for their effective support and help; and to the Agro-Industrial Section of UNIDO in Vienna for the possibility to complete the mission. The list of contacts is in Annex 8, which of course is not complete in view of all the persons who gave assistance to me and with whom I had the chance to discuss during the Symposium and the seminar.

List of participants at the "International Packaging Symposium" organized by Turkish Standards Institution Packaging Research, Development and Testing Centre

(Ankara, 23-24 June 1986, Turkey)

Institutions		Participants
Chambers of Commerce and Industry	4	5
Converters (including printing)	2	7
Manufacturers		53
Paper and boxes	3	
Tinplate	2	
Plastic films and containers	21	
Glass	1	
Universities		
(Agricultural and food engineering department)	7	19
State laboratories		
(Food testing and research)	28	58
Turkish Standards Institution	1	10
Consumers	15	28
Foreigners	5	5
<hr/>		
TOTAL	89	185

List of lectures and lecturers at the "International Packaging Symposium"
organized by Turkish Standards Institution Packaging Research, Development
and Testing Centre

(Ankara, 23-24 June 1986, Turkey)

Institutions	Number of	
	lectures	lecturers
Factories (producers)		
Paper	1	1
Tinplate	1	2
Glass	1	1
Machinery	2	2
Consumer	1	1
Research		
Trade	1	1
Standards	2	2
Scientific	1	2
University	3	3
Foreigners	4	3
Total	17	18

PACKAGING IN THE WORLD

I. VARSÁNYI - UNIDO Expert

The rapid technical development affects on a world scale all branches of the industry, in this way the production of packaging material and of packaging machines, too. As a result, the quantity of manufactured products increases, their choice widens and the quality improves. As packaging is a complex operation reflecting the development of several branches of the industry /e.g. chemical-, machine-, electronic industries, etc/, therefore the results of these industries achieved in the technical development can also be noticed in the production of packaging material and of packaging machines, too.

Packaging technique, however utilizes the operational research results of other branches, like in the manufacture of packaging machine, in the automation of packaging operations and in the development of the means of packaging.

If the question is being dealt with from the aspect of resources of raw materials /like paper-, metal-, plastic-, glass-, textile and in a certain sense the wood industry/, it can also be noticed that the new methods applied in the packaging and in the solutions of packaging, appear as a function of many sided and various industrial development.

As a summary we may state that all technical results which characterize the average technical level of each country appear in the packaging technique.

The purpose and the tasks of packaging

It is not necessary to prove that packaging is an important activity not only for a factory but for the economy, internal and foreign trade of a country. In the following a survey will be given on the situation of packaging with drawing the purposes and tasks of packaging.

Perhaps the most important function of packaging is the protection of the product from external effects. There are only a very few yields or manufactured articles not requiring special protection; however, it is undoubted that from the products of various industries, the food requires the most effective and careful protection. Here, the task is not only the quantitative protection of the food against external mechanical stresses occurring during mainly shipping and material handling but food must be protected to keep its nutritional quality and sensory value till consumption. This requires suitable materials /plastics, laminated materials, etc/ and methods.

Environment protection is also a very important aspect and requirement of packaging. Specially important is the more complete decrease of environment noxious effects of chemicals. The not properly packed chemicals may greatly contaminate the environment and in an extreme case may cause strong damages, too.

The further task of packaging is the suitable unit formation. Here, more aspects should be considered. The first, and perhaps the most important is the formation of the handling and shipping units. The task is that food should get to the consumers most economically, that is the cost of shipping to the place of destination should be the lowest as possible. These costs obviously include the costs of shipping, material handling and loading, too.

When units are formed the mode and the route of shipping, the mass and the volume of the shipping unit, the suitable construction of packs - in the interest of easy handling - have to be considered. In order to make the handling easier and to reduce the costs various shipping resources are available /such as tanks, plane and side-wall loading walls/.

The aspects of unit formation for storage also should not be neglected. The temporary storage of half- and end-products have to be the most economic at the factory, in the wholesale- and retail trade, in the equipment of transportation, in the shop, at the consumer, that is till consumption.

When selling and consumer units are formed, packaging has to fulfill the tasks connected to sale. Obviously, the interests of the consumers are in close connection with the marketing which appears first of all - for example in case of food-stuffs - in practical sizes to be formed for one or two persons or for the family.

The other important task of packaging is the information. Packaging in its appearance should not show more or even worse than what it covers, that is consumers should not be deceived about the quantity and quality of the product. Besides, packaging should contain all important information which promote the practical and safe material handling, the storage and the consumption. The importance of information is emphasized that for example a separate paragraph of the food law determines the information to be shown on the packaging or on the label.

The role of packaging in the protection of the product

The importance of packaging in food protection is recognized internationally. The protection against dynamic and static stresses means that food should get to the consumers undamaged.

In addition to this, the protection against climatic effects is also of importance. Suitable economic solutions have to be applied against the harmful effect of the temperature and humidity of air, wind, sunshine and so on.

Special mention must be made on the protection against corrosion which is particularly important in tropical countries. In case of nearly every product it is of basic requirement to protect the product against water and to keep the internal microclimate of packaging on an optimal level.

The protection against damages of biological origin must not also be neglected. Various microorganisms /moulds, bacteria/ attack usually both the packaging material and the food. Microorganisms are very active where temperature and moisture content create suitable conditions for their life. We must think also of the damages of macrobiological origin, too. One must count on the harmful effects of insects and rodents during shipping and storage. Commercial packaging does not ensure complete protection. Therefore, special attention must be paid to the storage, shipping and to loading places where micro- and macroorganisms are effective.

Main trends of development

Surveying the most important standpoints which determine the development of packaging, the question arises automatically what kind of trends were formed and what is the expectable development tendency on a world scale.

The most characteristic is that the ratio of the applied packaging materials are changing. It may be stated that the proportion of packaging materials of wood and textile decreases, while the proportion of metal-, and within it aluminium, and further more of plastic and laminated plastic packaging materials increases. This has a deep and wide economic effect especially in the developing countries.

The modern utilization of the presently applied packaging materials makes not only possible to extend the choice of the products but also aims at the increase of the buying mood taking into consideration the interests of the consumers /e.g. modern opening-, closing and feeding elements/. For the manufacturer it is essential to install packaging machines and packaging lines with higher output than the present which requires packaging materials and auxiliaries of usually better quality.

The application of modern auxiliaries such as protective paints may increase the protection against corrosion and at the same time with better appearance may call the attention of the consumer. Specially worth to mention the up-to-date closure elements for the hermetic seals.

Summary

It may be stated that on a world scale, economicalness, effect of advertizing and consumer interests are considered on a complex way. Endeavours aim at the material and energy saving solutions. The energy crisis in the world, the decrease of the available energy resources and the increase of energy costs obviously influence the economic solutions in the packaging industry.

Therefore, changes in the economic life require changes in the packaging, too. The economical aspects, especially in the developing countries delay the new investments. That is why, the presently available sources of raw materials should much better be utilized.

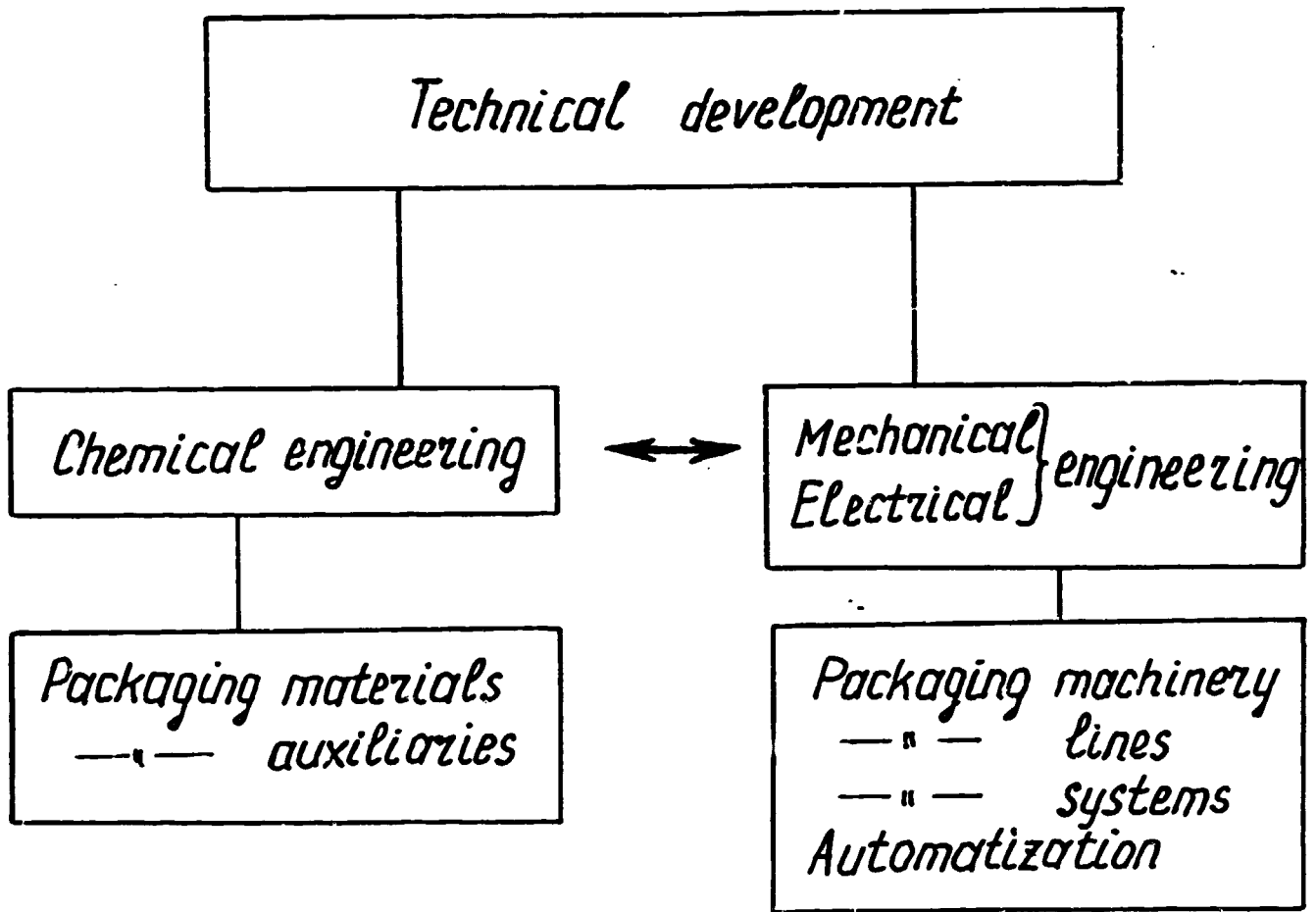
The material saving and at the same time the competitive packaging thus are not contradictory concepts of one and the other. The weight ratio of the packed product and of the packaging material, if favourably influenced, is not only economical but also a material saving solution. Machinerization

also includes a lot of reserves which is remarkable by all means. The modern packaging machines ensure good and suitable protection both for the material handling and for the consumers. The design of packaging also attracts consumers. The self-service system is widely used in nearly all branches of commerce. In this sense, packaging takes over the shop assistance's role, calls the attention of buyers to the products and stimulates the buying.

As a summary, it may be stated that as packaging is a rather complex technical activity, its development is in close connection with that of other industrial branches. The production of raw material for packaging, the machines manufacturing packaging materials, the packaging lines and their partial units reflect the technical level of different branches of industries. It seems that the international development trends are in close correlation with the social development and technical improvement. Special emphasize should be given to the possibilities in the division of labour and to its more wider employment.

I believe that this conference will offer good possibilities for the development of packaging technique, for the outline and indication of the tasks. I wish much success for this.

Packaging in the world



Purpose and task of packaging

Unit formation

- consumer packaging
(personal, family size)
- group packaging
(whole sale, retail trade)
- transport packaging
(handling, loading, shipping)

Protection

- quality
- quantity

Environment protection

- direct (dangerous materials)
- indirect (wasted materials)

Information

- formation (colour, size, etc.)
- labelling (according to the law or rule)

Product protection

— dynamic]
— static] stresses

— climatic effects (temperature,
humidity, wind, sunshine)

— corrosion

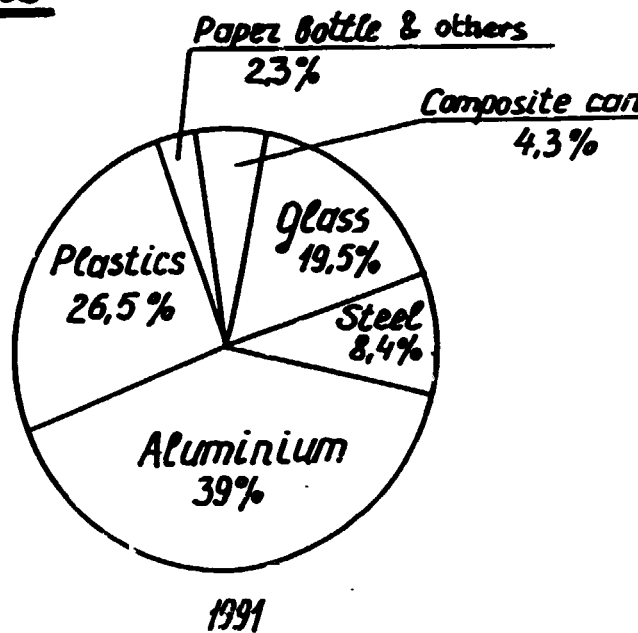
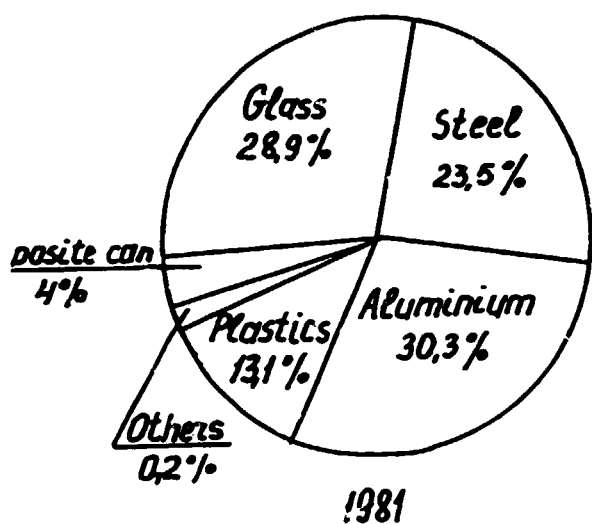
— biological effects

— microbiologic (moulds, bacteria)

— macrobiologic (insect, rodents, ants,
mouses, rats)

Main trends in the Application of packaging materials

Rigid containers



Aluminium	30,3%
Glass	28,9%
Steel	23,5%
Plastics	13,1%
Composite can	4,0%
Others	0,2%
	<hr/>
	100,0%

Aluminium	39,0%
Glass	19,5%
Steel	8,4%
Plastics	26,5%
Composite can	4,3%
Others	2,3%
	<hr/>
	100,0%

Main trends of development
of packaging materials

More:

— Polymers

— new types

— higher quantity

— Laminated materials

— plastic + plastic

— plastic + aluminium

— plastic + paper

— Metallized plastic-films

— Aluminium

Less:

— Wood

— Textile

— Steel (black)

Main trends of development of packages

- Material saving constructions
(higher quality, light packages)
- Extended shelf-life
- Product saving constructions
(dosage, opening, closures, etc.)
- Unit formation
(new wrapping methods and materials)
- New auxiliaries
(closure elements, paints and varnishes, ribbons, etc.)
- New machines and lines
(higher capacity, less deviation in the quantity, co-ordination of operations)

PRINCIPLES OF SHELF-LIFE DETERMINATION
OF PACKED FOOD

I. VARSÁNYI - UNIDO Expert

1. INTRODUCTION

To keep the quantity and the quality, sensory and nutritive values of foods for a long time is one of the main efforts of food scientists and food technologists. Basically two possibilities are existing for shelf-life extension: one is the development of preservation technology, including packaging, too; and the other is the optimization of storage parameters /temperature, relative humidity, light/, including that of the transportation, too. Obviously, shelf-life extension also involves financial consequences. Optimization of the rates of certain expenses - like for example the energy requirement of preservation; the cost of wrapping material or the distribution - are also very important from the point of view of shelf-life extension, however, its detailed discussion and description is beyond our given limits.

The main purpose of the investigation is to determine the shelf-life of raw materials, half- and end products. Therefore, it is necessary to study the deterioration mechanism and dynamism of foods and to select the factors which could be influenced and modified for keeping the quality of foods.

2. MATERIALS AND METHODS

It is necessary to observe and analyse the quality changes of different foods produced and put on the market, which are practically from all branches of the food industry.

The principle of the investigation is to study the changes of the characteristic properties in the differently stored and packed food in the function of storage time. Accordingly, - depending on the type of food, - the following changes have to be determined: biological values /protein-, fat- and vitamin content, etc/, chemical-physical properties /consistency, pH value, water content, colour/, microbiological state, and sensory properties /appearance, odour, taste, colour.

Measurement methods applied for the determination of changes have to be according to the national, industrial or international standards.

To determine the type and quantity of changes, searching stochastic relationships between the storage time as independent variable, and the property/ies/ characterizing the quality changes is possible by continuous mathematical models. Therefore, in order to characterize the quality of food, the most rapidly changing important property must be selected by mathematical statistical method. By variance-analysis, the most important property characterizing the quality change of food is determinable, regarding the given packaging and storage as constants. The property selected, - characterizing the quality changes of foods -

is regarded "critic", and the measured values are useful in function of time to formulate the relationship between the storage time and the quality changes.

After that curve fittings are done to describe the quality changes of different food and the most characteristic function to product or product group is, where the deviations between the measured and the calculated data $/S_y/$ are the smallest.

3. RESULTS

Analysing the relationships which describe the quality changes of different food and food groups in function of time, it is possible to set up the following type of models as most characteristic ones:

- linear model: $y = a + bx$
- quadratic model: $y = a + bx^2$
- hyperbolic model: $y = ax^{-b}$
- exponential model: $y = ae^{-bx}$
- sigmoid model: $y = ae^{-bx^2}$

where

y = value of quality

x = storage time

a = regression constant, the values usually are according to standard $/a \leq 0.33$ is recommendable/

b = regression coefficient, the value characteristic to the rate of quality change.

Mathematical-statistical method is also used to select the most suitable function which describes the change. The confidence of models, that is the accuracy of curve fitting - where it was necessary using transformation - is calculated by error of variance. The model describes the quality changing of the given food or group of foods the best, where the error of variance of expectation is the smallest, as follows:

$$S_y^2 = \frac{\sum_{i=1}^k |y_i - \hat{y}_i|^2}{n - 2}$$

where S_y^2 = value of residual variance
 y_i = measured value of quality characteristic at time i
 \hat{y}_i = estimated /calculated/ value of quality characteristic at time i
 n = number of measurements

4. CONCLUSION

Factors resulting the value of shelf-life are determinable by objective mathematical statistical analysing methods with good confidence.

Analysing the quality changing models, it can be found that some of the factors influencing the value of regression constant $|a|$ are important from the

point of view shelf-life. These main factors are: the quality of raw materials, the total effect of the treatments during preservation technologies which determine the quality of packed end-product. Smaller the differences between the quality of raw materials to be processed and of the end-product, the longer the shelf-life is.

Accordingly, it is possible to work out technologies and recipes /for example applying inhibitors/ which promote the preservation of sensory and nutritive values; and also considerate preservation procedures which ensure the internal value in the raw material/s/ the best.

Further analysis of quality changing models show that another important aspect is to reduce the effect of factors which influence the value of regression coefficient /b/. Factors such as: ensurance of the hygienic state /change in the number of germs/ of the product, inhibition of oxidation and all other effects which change the food's colour /e.g. light/, consistency /e.g. water content/ and flavour /e.g. enzymic actions/.

These changes may be inhibited or restrained if already started by proper packaging technique and also by suitable storage /e.g. low temperature/ and transportation conditions /prevention of thawing/.

Summarizing; the method recommended for shelf-life investigations, it can be stated that following the mechanism of quality changing in raw materials, half- and end-products by the 5 different mathematical

models, the confidency is less than 10% in average. Explaining the models and analysing the constant in the functions, not only the quality changes of food and the time of reaching the critic, - still acceptable value - can be predicted, but parameters of quality processing, preservation and packaging, storing may also be determined; by changing them, accordingly the shelf-life of foods will change, too.

1. Figure

MAIN CAUSES OF FOOD QUALITY CHANGES

- CHEMICAL: OXIDATIVE CHANGES (FLAVOURS, AROMA, LIPIDS, DYSTUFFS)
- PHYSICAL-CHEMICAL: WATER CONTENT CHANGING
- PHYSICAL: - COLOUR CHANGING BY LIGHT EFFECT
 - RHEOLOGICAL BEHAVIOUR CHANGING BY HEAT EFFECT
- MICROBIOLOGICAL: - CELL COUNT NUMBER INCREASING

2. Figure

CRITERIA TO SET UP CONTINUOUS MATHEMATICAL MODEL FOR PACKED PRODUCTS

- DEFINITION OF THE MOST RAPIDLY CHANGING PARAMETER/S/
OR PROPERTY/IES/
- THE POSSIBLE LOWEST VALUE DEFINITION OF PARAMETER/S/
OR PROPERTY/IES/ ACCORDING TO THE NATIONAL OR PRODUCT
STANDARD
- DEFINITION OF EXTREME CIRCUMSTANCES (TEMPERATURE,
RELATIVE HUMIDITY, LIGHT) FROM THE PRODUCTION TO THE
CONSUMPTION

3. Figure

PROCESS OF CURVES FITTING

- DATA ANALYSES AND SELECTION BY MATHEMATICAL-
- STATISTICAL METHODS
- REPRESENTING SELECTED CHARACTER/S/ IN THE FUNCTION OF STORAGE TIME
- FUNCTION APPLICATION TO DESCRIBE THE CHANGE
- ERROR CALCULATION

Figure 4.

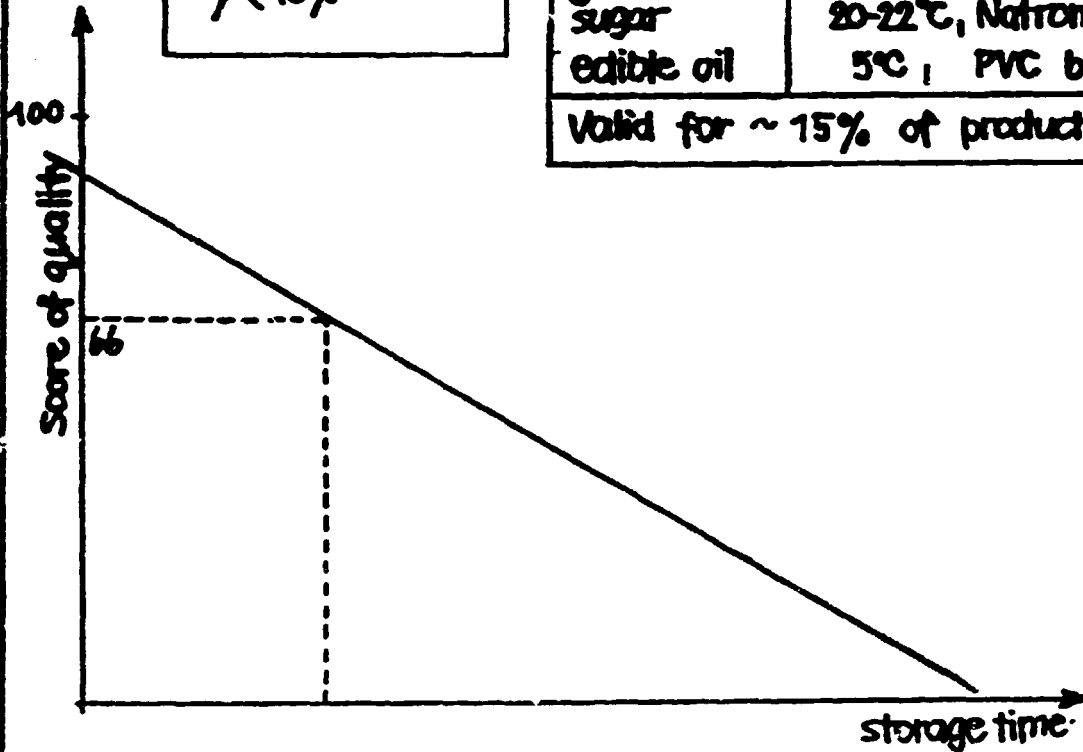
MODEL

$y = a + bx$
$a_{max} > a > \frac{1}{3} a_{max}$
$Sy < 10\%$

APPLICATION

Products	Storage and Packaging
Poultry	-15°C, -15°C; Polyethylene bag
salmonies	5-7°C, —
powdered sugar	20-22°C, Polyethylene bag
granulated sugar	20-22°C, Natron paper
edible oil	5°C, PVC bottle

Valid for ~ 15% of products



LINEAR CHANGE OF QUALITY CHARACTER

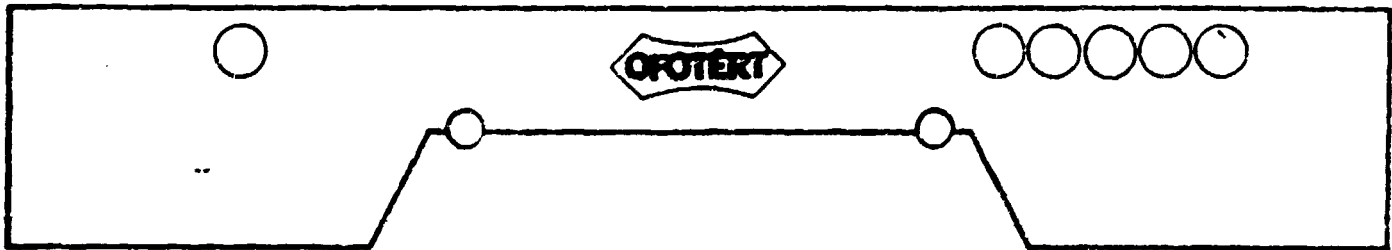


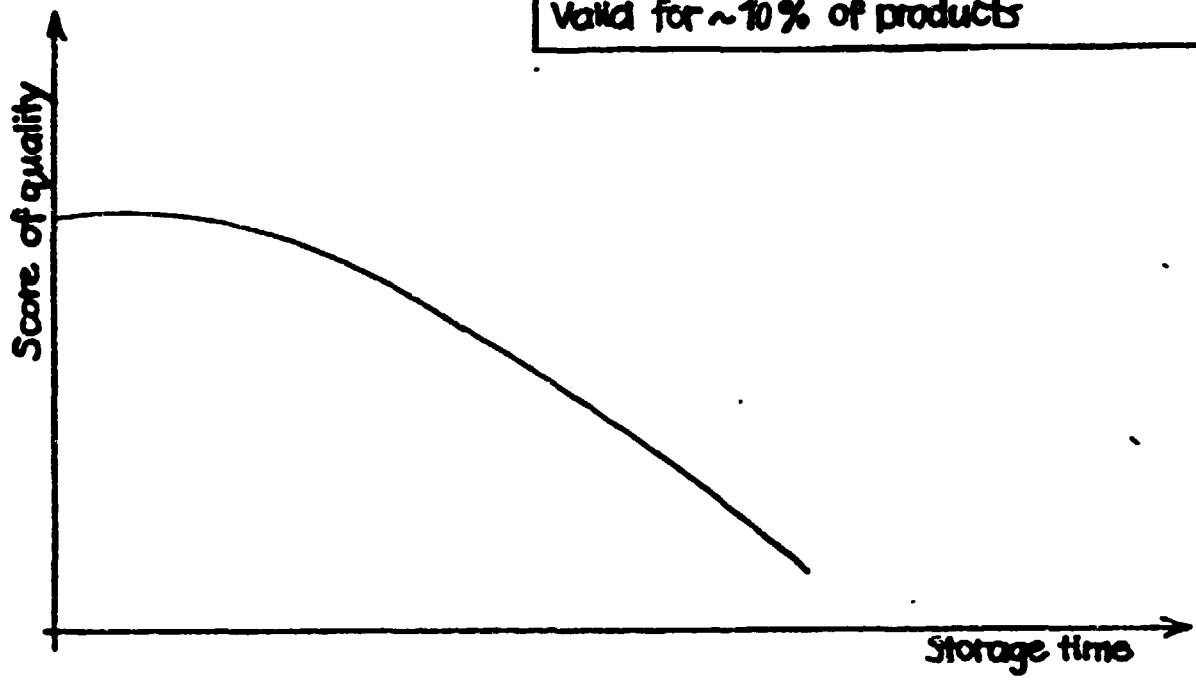
Figure 5.

MODEL

$y = a + bx^2$
$a_{max} \geq a \geq \frac{1}{3} a_{max}$
$Sy < 10\%$

APPLICATION

Products	Storage and packaging
quick frozen foods	-18°C - +5°C; plastic bags, paper boxes, etc.
Valid for ~10% of products	



QUADRATIC CHANGE OF QUALITY CHARACTER

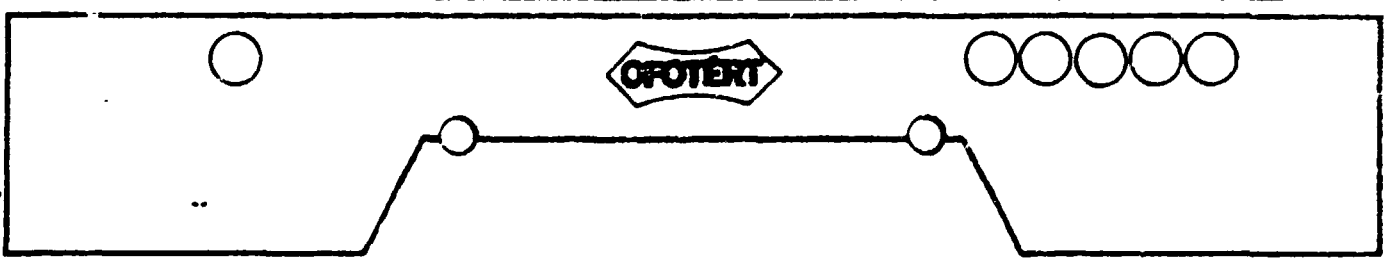
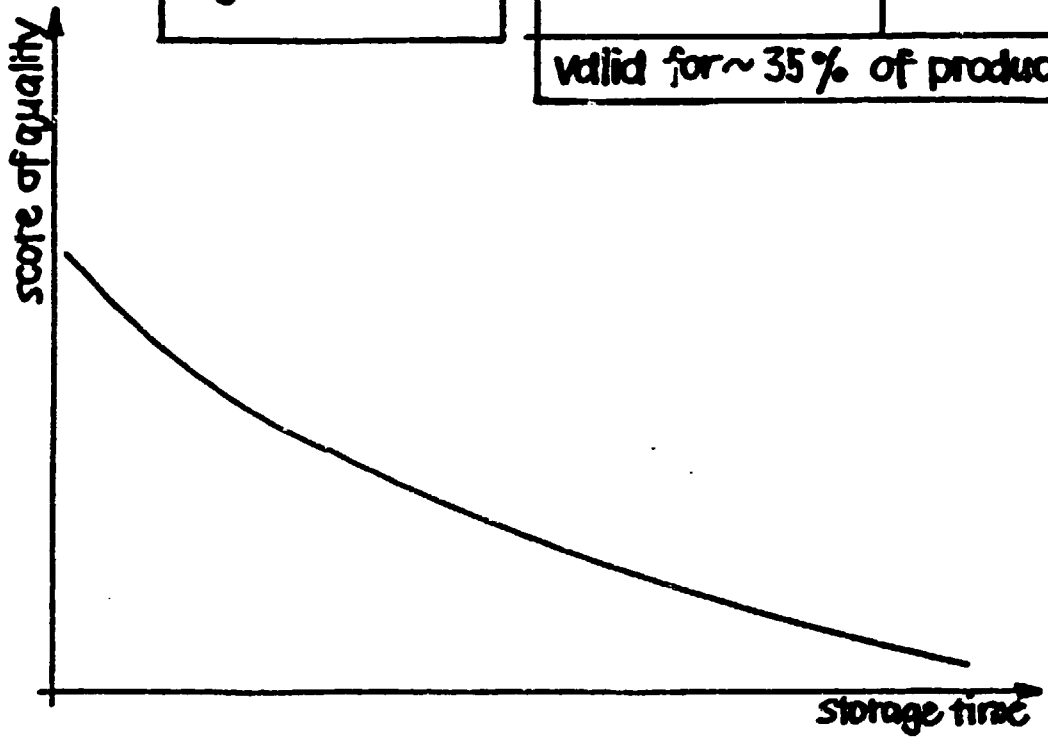


Figure 6.

MODEL	APPLICATION	
$y = ae^{-bx}$	Products	Storage and packaging
$a_{max} > a > \frac{2}{3}a_{max}$	leg of pork canned meals egg nog baker's yeast	5-7°C full-wrapped 20-22°C tin-can 20-25°C bottle 5°C paper
$S_y < 10\%$	valid for ~ 35% of products	



EXPONENTIAL CHANGE OF QUALITY CHARACTER

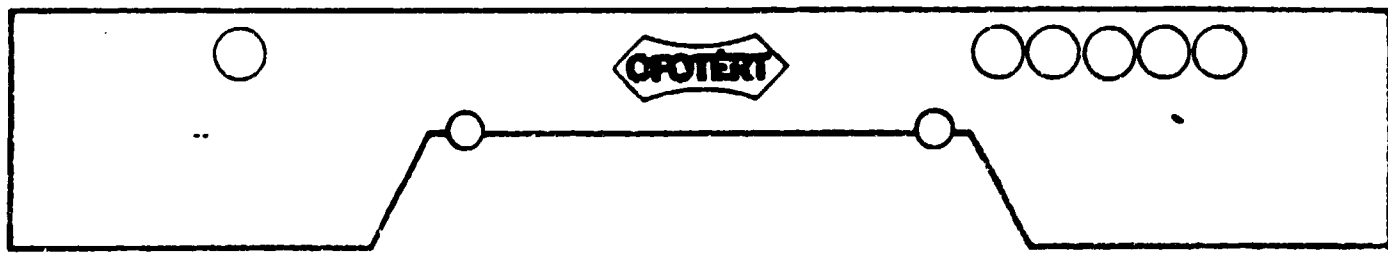


Figure 7.

MODEL

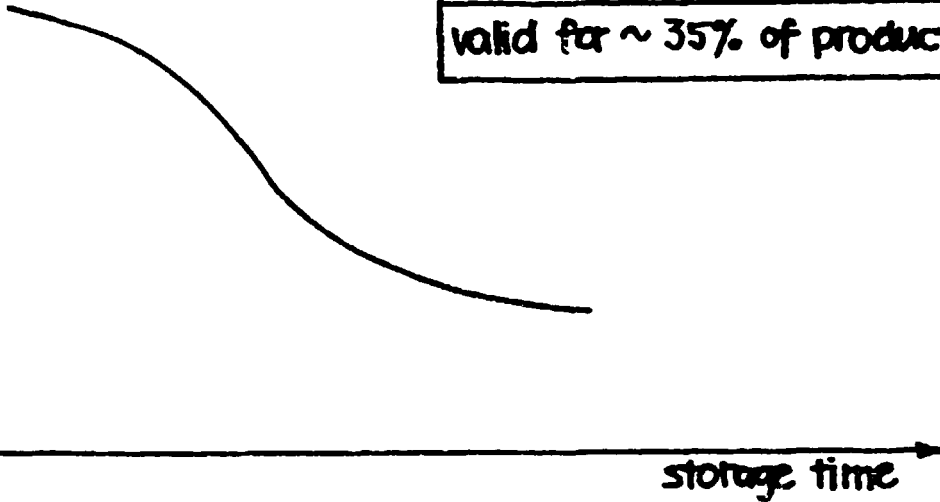
$y = ae^{-bx^2}$
$a_{max} \geq a \geq \frac{2}{3}a_{max}$
$Sy < 10\%$

APPLICATION

Products	Storage and packaging
bakery goods	20-25°C paper wrapped
soft drinks	5°C, 20-22°C bottles
flours	20-22°C paper & textile bags
pasteurized skinned milk	0°C-25°C polyethylene bag
butter	0°C-25°C wrapped or plastic container
margarines	0°C-20°C alufoil wrapped

valid for ~ 35% of products

score of quality



SIGMOID CHANGE OF QUALITY CHARACTER

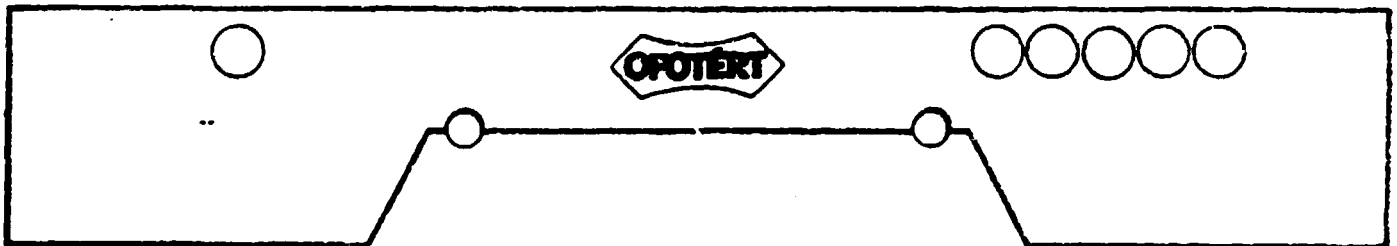


Figure 8.

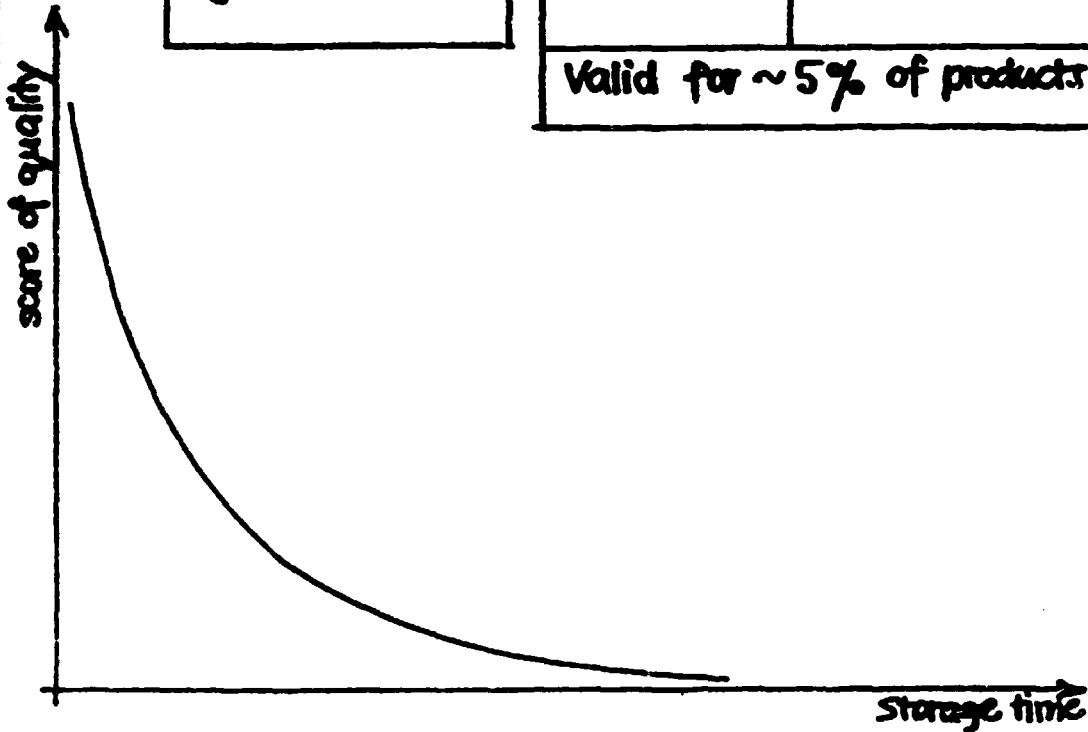
MODEL

$y = ax^{-b}$
$a_{max} \geq a \geq \frac{2}{3} a_{max}$
$S_y < 10\%$

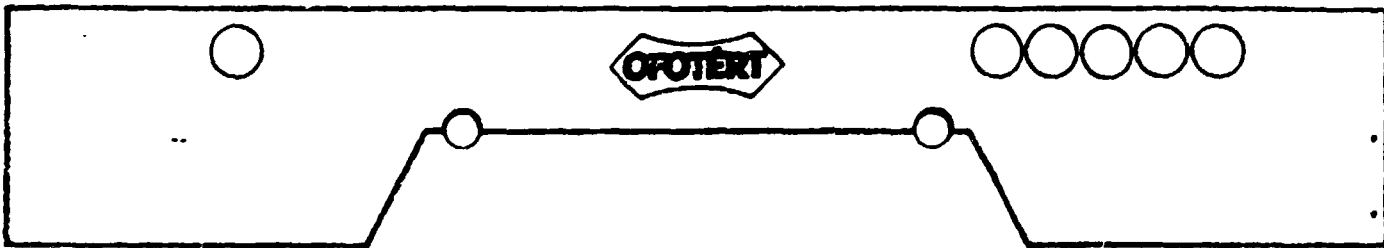
APPLICATION

Products	Storage and packaging:
sauisages	20-22°C —
sliced Lacon	20-22°C celthene bag
leg of pork	20-22°C foil-wrapped
fresh fruits	15°C over-wrapped trays

Valid for ~5% of products



HYPERBOLICAL CHANGE OF QUALITY CHARACTER



MATHEMATICAL-STATISTICAL CHARACTERS
OF THE ACCURACY AND REPRODUCIBILITY OF
DETERIORATION MODELS

RESIDUAL VARIANCE:

$$S_y^2 = \frac{\sum_{i=1}^n /y_i - \hat{y}_i|^2}{n-2}$$

VARIANCE OF REGRESSION CONSTANT:

$$S_a^2 = \frac{\sum_{i=1}^n e_i^2 \sum_{i=1}^n x_i^2}{n/n-2 / \sum_{i=1}^n /x_i - \bar{x}|^2}$$

VARIANCE OF REGRESSION COEFFICIENT

$$S_b^2 = \frac{\sum_{i=1}^n e_i^2}{n-2 / \sum_{i=1}^n /x_i - \bar{x}|^2}$$

y_i measured value of dependent variable at time i

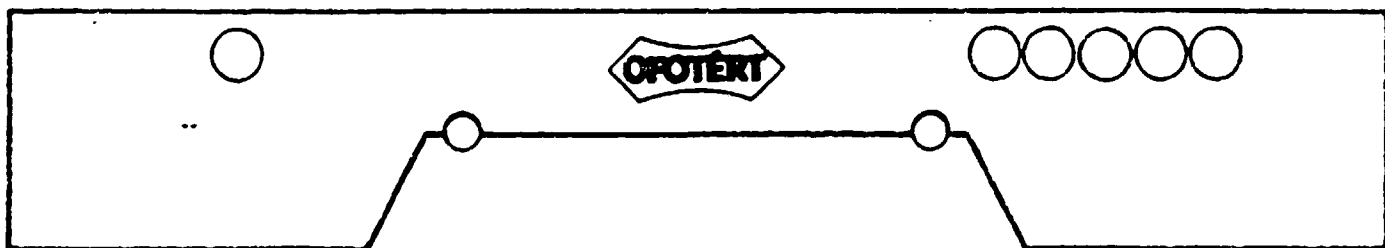
\hat{y}_i estimated value of dependent variable at time i

x_i measured value of independent variable at time i

n total number of measures

\bar{x} mean value of independent variable

e_i^2 residue = $|y_i - \hat{y}_i|^2$



10 . Figure

EVALUATION AND RESULT

- DEFINITION OF CRITICAL STORAGE TIME
- OPTIMIZATION OF PACKAGING MATERIAL AND FORM
- DETERMINATION OF STORAGE CIRCUMSTANCES
(TEMPERATURE, RELATIVE HUMIDITY, LIGHT)
- LABELLING OF FOODS

**DRAFT COMMUNIQUE OF THE RESULTS OF THE PACKAGING SYMPOSIUM
TO BE ISSUED BY TSE**

INTERNATIONAL PACKAGING SYMPOSIUM (II)

International Packaging Symposium (II) which was covered in the activities of Turkish Standards Institution Packaging Research, Development, Testing Centre was done between 23rd and 24th of June in the Turkish Standards Institution.

The opening speech was done by Minister of Health Mr. Mehmet Aydin. Mr. Pierre Schmit President of World Packaging Organization, Ivan Varsanyi, UNIDO food expert and Mr. Cevdet Senv from Turkish Republic of North Cyprus had participated by presenting papers. Also, a representative had participated as listener from Saudi Arabia.

17 papers were presented and a panel was taken place about "Proposals on the Progress of Packaging". Other than the Foreign guests, totally 180 people had participated from packaging materials manufacturers, from packaging materials consumers, from universities, from Industrial and Commerce chambers and from the Public establishments to symposium.

Subjects of the presented papers in the symposium included the opinions about packaging in the World trends and progresses, the requirements of the food packaging; principles of the determination of shelf-life of packaged foods, laminated packaging materials, corrugated board; and progresses on the metal and glass packaging.

In addition to these subjects, information was given about a research study and a design project results which were done by the Packaging Research, Development and Testing Center.

The results of the discussions had taken place in the panel are the followings:

- Consumer should have been conscious about packaging
- It is necessary to continue importing of packaging materials, because the confidence is insufficient from the point of amount and quality in the domestic market.
- It is necessary to make more cooperation between the packaging materials manufacturers and consumers.
- It is necessary to follow more closely the progress of packaging technology in abroad and it is necessary to participate more often fairs and exhibitions.
- Optimization is necessary in the usage of packaging.
- Packaging materials which should be used should be absolutely tested for quality and performance.
- Packaging Engineering Department should be set in the Universities.
- Preparation of packaging standards should be gained speed.

Likewise, a packaging exhibition was opened between 23rd - 28th of June and 17 Foundation had participated to this exhibition.

The importance of the International Packaging Symposium (II) from the angle of our Country:

- Our studies about packaging was announced to foreign countries.

- *The subject was examined carefully from the different angles as packaging manufacturers, consumers and the other organizations were coming together.*
- *Packaging exhibition gave to see the situation of packaging industry in Turkey and progresses more nearly.*

The International Packaging Symposium was ended by wishes the participants to come together in the International Packaging Symposium (III).

SEMINAR ON SHELF-LIFE DETERMINATION
OF PACKAGED FOODS

Organized by
Turkish Standards Institution

1st JULY 1986

ANKARA

- Place : Turkish Standards Institution
Packaging Research, Development and
Testing Center, Training Section
- 14.00-14.05 : Opening Speech
Mr. Hilmi ISMAILOĞLU
Secretary General-Turkish Standards Institution
- 14.05-14.15 : Activities of Packaging
Research, Development and
Testing Center
Ms. Gulden TARHAN
Director-Turkish Standards Institution,
Packaging Research, Development and
Testing Center
- 14.15-15.00 : General Principles of Shelf-life Determination
of Packaged Foods.
Mr. Ivan VARSANYI
Food Packaging Expert - UNIDO
-
- 15.00-15.45 : TEA BREAK AND VISITING THE LABORATORIES
-
- 15.45-16.15 : A Research Study on the Determination of
the Shelf-life of Vacuum Packaged Sausages
Ms. Nihal TEMUR
Chemical Engineer
Turkish Standards Institution
Packaging Research, Development and
Testing Center
- 16.15-17.30 : Discussion

**List of participants at the seminar organized by Turkish Standards Institution
Packaging Research, Development and Testing Centre
(Ankara 1 July 1986)**

Institutions	Participants
<hr/>	
Industries	
Milk	2
Confectionary	3
Meat	2
Sugar	1
Canning	6
Packaging	4
Research, testing, quality control	9
University	2
Others	2
<hr/>	
Total	14
	31

LIST OF CONTACTS

United Nations Development Programme (UNDP), Ankara

Mr. S.K. Malik, Resident Representative, UNDP
Mr. P.H. de Jonge, Deputy Resident Representative, UNDP
Mr. R. Tourigny, Programme Development Officer, UNDP
Mr. W. A. Dreusch, Junior Professional Officer, UNIDO

Turkish Standards Institutions (TSE), Ankara

Mr. N. Esen, Vice-President
Mr.H.H. Ismailoglu, General Secretary
Mr. I. Atikler, Head of Laboratories and Quality Control Department
Ms. G. Tarhan, Director of Packaging Centre

State Planning Organization

Ms. D. Ulguray, Food Sector Expert

Middle East Technical University

Mr. S. Urgan, Chairman of Food Engineering Department
Ms. G. Gencer, Assist. Prof. of Food Engineering Department

University of Ankara

Mr. A. Eksi, Assoc. Prof. of Faculty of Agriculture
Mr. L. Cakici, Professor of Political Science-Management Department

EGE University

Mr. E. Saygin, Professor of Food Engineering Department

Export Promotion Research Center

Ms. G. Otaran, Expert

DYO-SADOLIN Co.

Mr. F. Das, Director

Eregli Iron and Steel Works, Inc.

Mr. F. Karaoglu, Chief Director of Quality and Metallurgy Section

Turkish Bottle and Glass Factories

Mr. Y. Yigit, Director

World Packaging Organization

Mr. P. Schmit, President

Pinar Dairy Products Co.

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