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PROBLEMS IN DEVELOPING A FOOD PROCESSING INDUSTRY FOR EXPORT[1]

by

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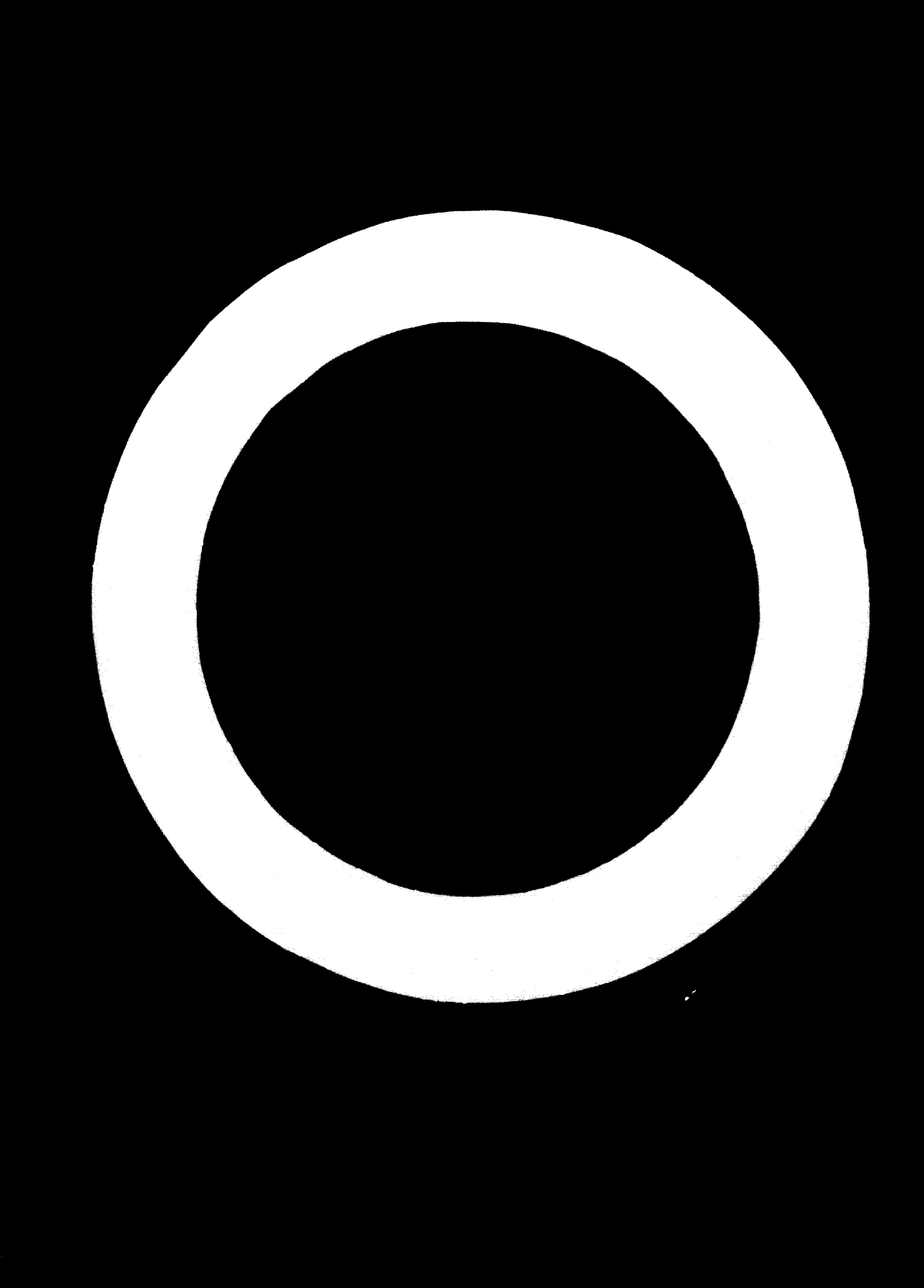


INDUSTRIAL CROPS

Among the critical factors in developing industry in general and export specifically, are the availability of a proper infrastructure for the pertinent industry This includes first of all the availability of suitable raw materials, packaging and auxiliary materials, roads , utilities and transportation and last but not least availability of personnel at all levels of training with proper know-how for the specific industry

The great advantage of the agro-based industries is that they make use of renewable materials which can normally be harvested season by season. The corresponding disadvantages are that the materials are of biological origin so that they may vary widely in their shape,, appearence and composition and they are readily subject to deterioration. The modern food industry in general and the one geared for export specifically must pay special attention to the quality of raw materials so as to ensure the quality of their final products. Food processors require their industrial raw materials (i.e. fruits, vegetables or animal produce to be not only of the right quality but also to be in the proper quantities and at fixed times. This concept of "Industrial Food Crops" often involves a change in agricultural practices because produce which is suitable for the fresh market is by no means the optimum raw material for processing. For example, fruits for the fresh market should be ripe, tender and juicy, while those for the industry must be of such consistency that will enable them to withstand handling and processing. Produce such as corn and peas, which respire fast after harvesting and rapidely change their texture from a tender sweet to a tough starchy one, must be processed within hours after harvesting. Furthermore, the growing and harvesting of industrial crops has become highly mechanized by using specialized mechanical pickers and this naturally requires adaptation of field practices to the equipment. Since the food industry requires its raw materials in fixed quantities over a specific period of time with a limit of spray residues and other undesirable components, it must have control over planting practices and harvest time

All this leads us to the need of direct contact between farm producer and processor and the need for setting up specifications for the produce. The contract between producer and processor should specify the following:

a) Quantities to be supplied and schedule of supply at fixed harvest dates.

b) Quality of material to be grown (i.e. variety, agrotechniques and methods of evaluating quality including sampling procedures).

c) Price per unit weight multiplied by a predetermined quality factor.

d) Tolerances of spray residues.

e) Means of transport i.e. in bulk, in large or small containers.

In order to be able to supply raw material based on such terms certain basic data must be available.

a) For the determination of a sowing plan and harvest dates, knowledge of growing conditions in the specific location and of the specific variety are necessary. One method of predicting growing period and harvest dates is the "Heat Unit System" (Seaton, 1955).
This system is based on the assumption that any crop does not grow below a certain temperature and growth above this temperature is proportional to time and difference in temperature.

Therefore a heat unit day (HU) equals mean daily temperature($\bar{t}$) minus minimum temperature (t min).

$$HU = \bar{t} - t\ min.$$

Based on average mean daily temperatures obtained from the meteorological services, and knowledge of growing condition of the specific crop in terms of total Heat Unit days needed to reach maturity, corresponding harvest plans can be devised.

b) Quality criteria for the raw material are dependent on the planned final product. For example, different criteria will exist for tomatoes designated for concentrate and for peeled tomatoes. The former fruit should be high in solid content and have an intense color but their shape, size and appearence are of no importance. Fruit for peeling on the other hand must be uniform in size and have a proper shape and be easy to peel. Different criteria exist for juice grapefruit than for grapefruit intented for segments in syrup. For the latter purpose fruit of a certain size range should be hand picked and brought with minimum handling directly to plant. Such fruit in Israel fetches about double the price than fruit for juice.

All quality parameters and methods of evaluating them should be fixed in the contract between grower and processor. If possible, Objective tests such as Munsell color discs for color or shear press for tenderness should be specified. In order to avoid conflict between parties a reliable sampling plan should also be agreed on. A sample specification and inspection proposal for tomatoes is given in Appendix A.

c) Payment for raw material should be based on a product of weight times quality. For example, the basis of payment for sugar beets or sugar cane is the product of weight of clean material times sucrose content. Citrus in Florida are received and paid for on a juice yield times soluble solids basis as established on receipt in factory. Milk is usually paid for on a volume times fat content basis. Similarly, other products should be priced, taking into consideration, besides gross weight, yields and quality.

d) Most developed countries have strict tolerances for spray residues mainly for health reasons. In addition to spray residues some other unintentional minor contaminants may have adverse effects on the product quality or its shelf-life. For example, high nitrate content in produce such as tomatoes, beans or melons has been proven to cause severe internal corrosion in the canned product. The nitrate may be present in the produce due to high nitrate content in the soil or high salinity of water.

e) Means of transport are important to ensure rapid mechanical handling in factory and in case product must be stored or cooled prior to processing, facilitate these steps. While transport in bulk or large containers is more efficient, it requires expensive mechanical equipment which may not be available at either end of production chain in a developing country, and therefore old fashioned field boxes may have to be used.

PROCESS ADAPTATION AND DEVELOPMENT

Food plants in developing countries have often failed due to the introduction of too sophisticated methods and equipment for the particular case. When considering establishment of a food processing plant in a developing country one should never copy blindly methods used in other places for several reasons. Equipment used in American plants, for example, is usually geared to a very specialized high speed production technique based on the assumption that labor is scarce and expensive. Therefore, automation and labor saving devices are sought and used. In developing countries on the other hand equipment usually should be versatile. Furthermore, since common labor is stillreadily available,but skilled technicians needed to operate sophisticated equipment are scarce and expensive, techniques used should be simple, foolproof and require little skills without sacrificing quality. This does not imply that modern methods should not be used but they must be adapted to local conditions.

Citrus fruit are one of the most important crops in Israel and therefore considerable efforts have been put on developing processed citrus products which can serve as examples for this point.

Grapefruit segments in syrup

Initially (about 20 years ago) the American method consisting of scalding the whole fruit, peeling flavedo and albedo, dipping entire peeled fruit into caustic soda solution and then segmenting by hand was used in Israel. However, it was quickly found that this method was not the best for our fruit and low yields were obtained. Procedures were changed and instead of dipping whole fruit into soda solution, fruit was first segmented and segments were then subjected to lye peeling. Losses were reduced, labor saving was found and appearance of final product was improved.

obtaining proper drained weight in this product posed another problem. Research showed that by changing filling procedure and using dry sugar and water instead of syrup, and changing rotary pasteurizers to still pasteurizers great savings in raw material were achieved. (Berezovsky, [illegible]). Another saving, mainly in energy and space, was obtained by changing exhaust baths to steam injection closing. Vacuum syruping was not found to be effective and not worth the high investment needed to it. A summary of changes in production procedure over the years is given in Fig. 1.

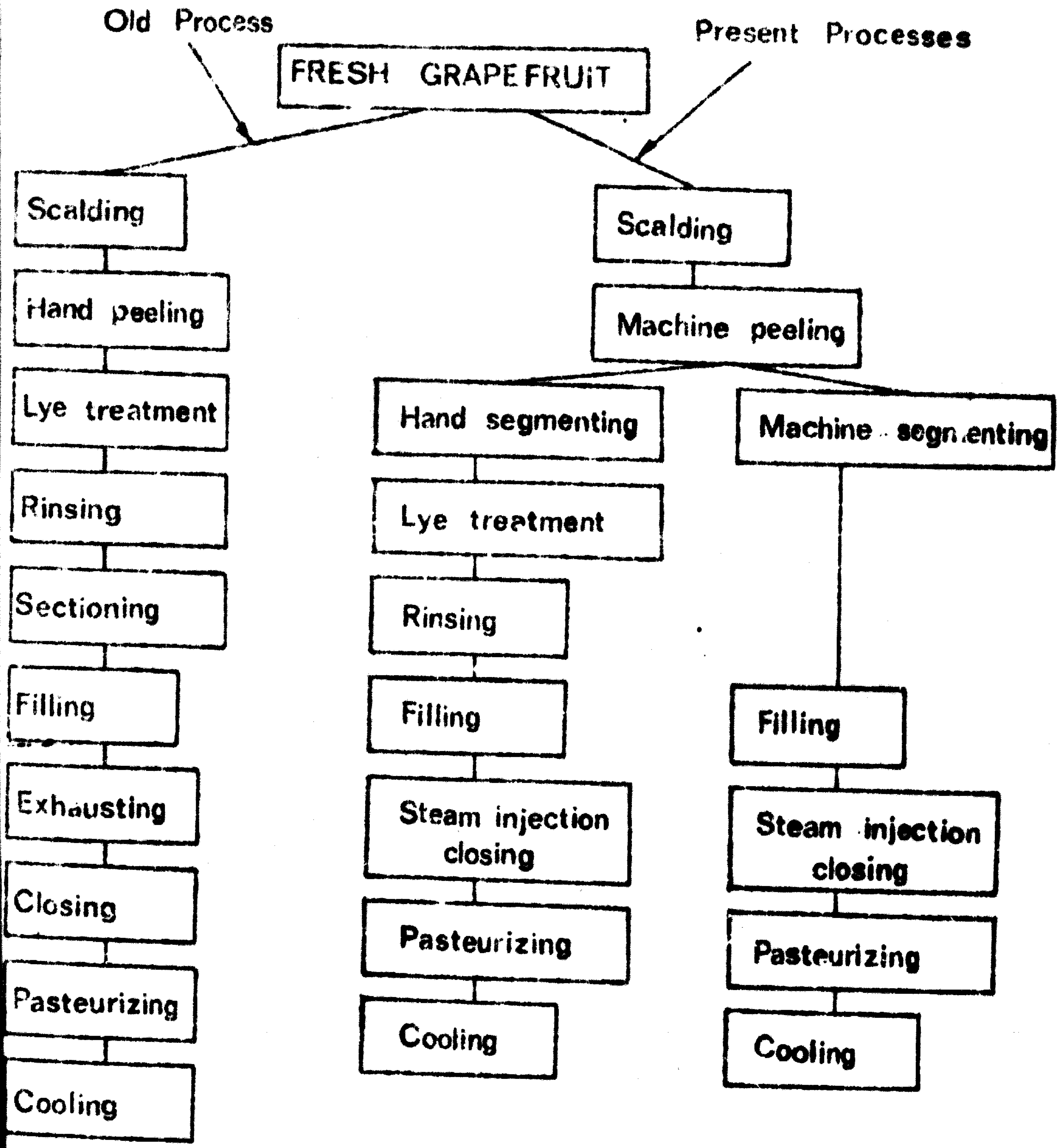
At present further changes are under investigation including introduction of mechanical flavedo-albedo peelers and automatic segmenting equipment. Due to difference in shape of our fruit v.s. American fruit for which equipment was designed, adaptation, including slight changes in equipment, are necessary.

<u>Citrus comminuted bases and juices</u>

In search for a profitable outlet for peels and other remnants remaining after citrus juice extraction, comminuted products designed as beverage bases were developed. In this case the relatively small scale of the Israeli industry turned out to be an advantage since it enabled it to prepare tailor made products for specific foreign customers.

Various production techniques were described in the scientific and patent literature. (Bravermann, 1960; Charley, 1963; British Patents 934,347 and 934 348). The technique most commonly used today consists of disintegrating the peel of extracted fruit, grinding it in a colloid mill and mixing paste with fixed amounts of juice and other additives to obtain desired final product. Another method consists of disintegrating whole fruit, heating and pressing mass to separate seeds and then finishing as before. A common problem to all these

Fig.1 FLOW DIAGRAMS FOR CANNED GRAPEFRUIT SEGMENTS



problems as to [illegible] of air into the viscous mix, especially at the colloid mill stage. This can be avoided by using closed mills, working under a nitrogen atmosphere or applying a proper deaeration technique (Hoenig 1967).

A more recent technique used to make drink "bases" is based on washing pulp and peel fragments, centrifugal separation and concentration of liquid portion to obtain the drink base. The important property of these bases is their cloudifying effect, while taste and color are adjusted according to specific customer requirements. One of the problems in preparing these products was their relatively low shelf-life due to corrosion in unlaquered as well as lacquered cans. Mannheim & Hoenig (1971) investigated changes accurring in storage of these products as affected by type of can and product. Storage temperature had the most pronounced effect on browning and lacquered cans had an adverse effect on this parameter. Corrosion, as measured by tin dissolution, was more severe at high pH and in electrolytic cans (Fig. 2). A significant decrease in apparent viscosity was found after one year's storage.

Centrifugal separation of tomato and orange juice into serum and pulp with the aim to improve aroma retention and heat transfer coefficients is another example of adapting a process for specific needs. Kopelmann & Mannheim (1964) showed that by using this method heat transfer coefficientswere superior and typical citrus evaporators could also be used for tomato concentration. Peleg & Mannheim (1970) showed that when applied to citrus this process enabled efficient production of a high quality orange concentrate. This is process is illustrated in Figure 3.

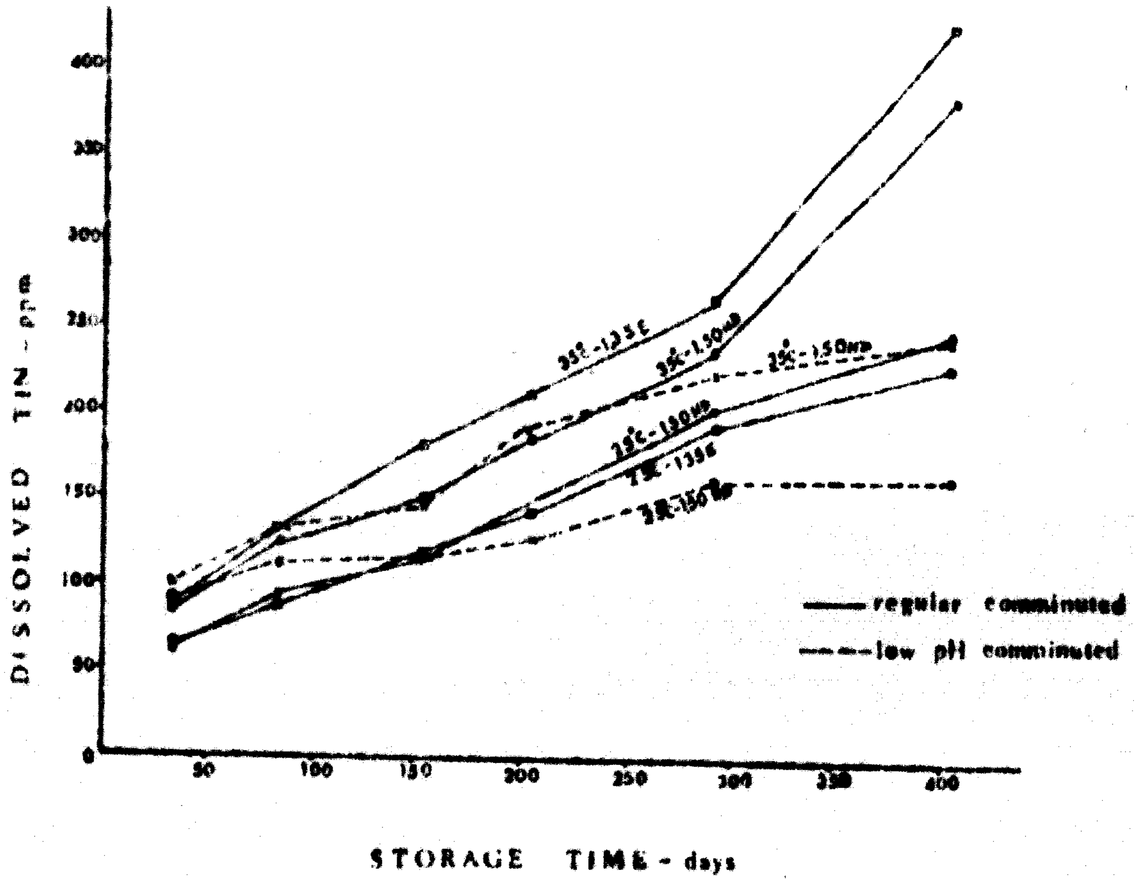
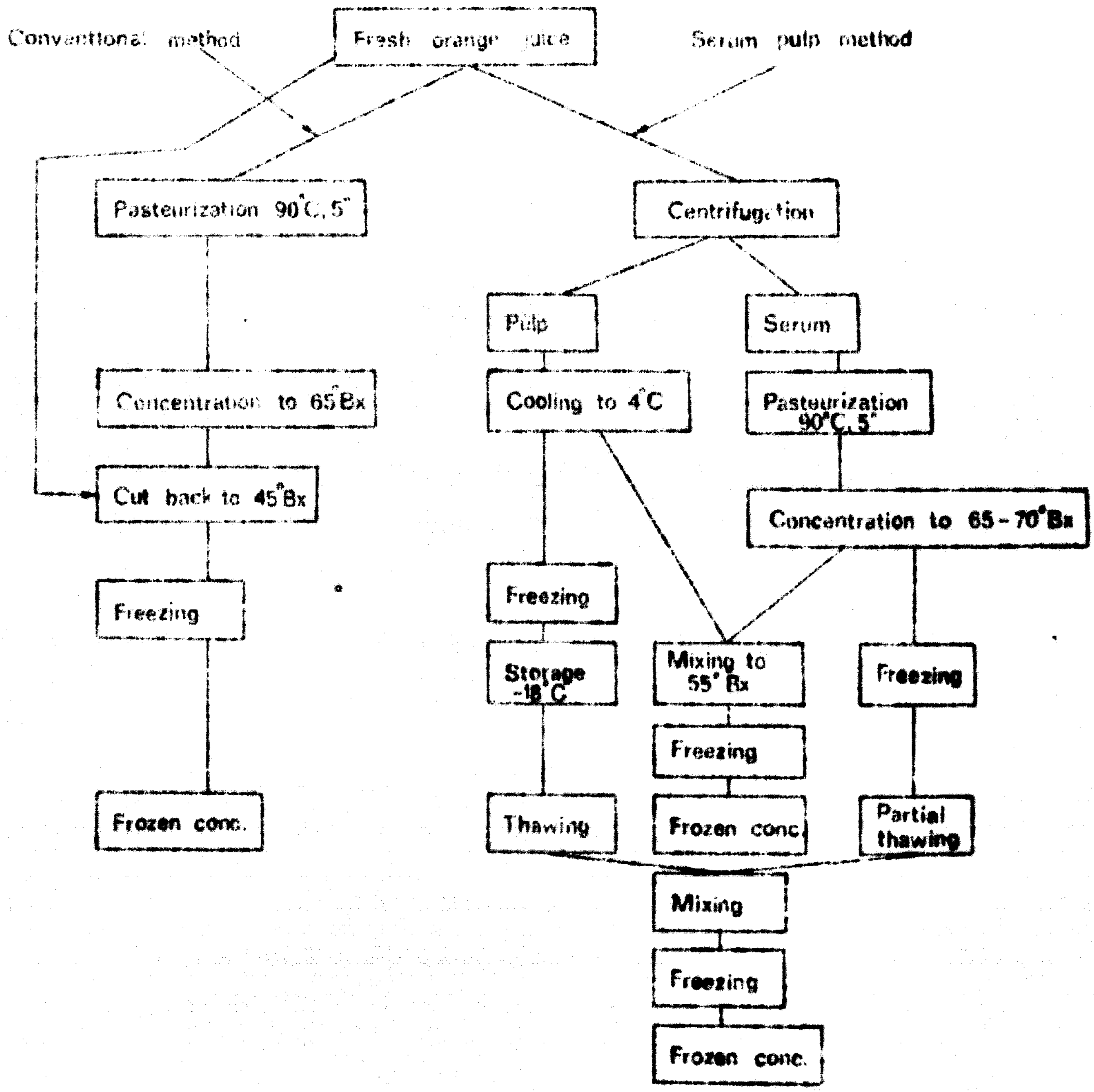


Fig. 2. Dissolved tin content of comminuted orange at two pH levels in different A/2 cans during storage at 25 and 35°C.

Fig. 3 SCHEMATIC DIAGRAM OF PREPARING CONCENTRATE BY THE COVENTIONAL AND SERUM - PULP METHOD



Melons in Syrup

Canned melons in syrup were found to be a pleasant and lucrative export item. Special varieties were developed but severe corrosion in unlacquered cans occurred sporadically. Using cans with normal fruit lacquer spoiled the delicate flavor of this product and caused severe browning. An investigation into the causes of the corrosion phenomena showed that it was due to the high air content in the fruit tissue combined with high nitrate content especially in presence of iron compounds. Vacuum syruping procedures were adapted for air removal and prevention of corrosion and browning. The effect of various exhausting procedures on tin dissolution are demonstrated in Table 1 (Mannheim , 1971).

Table 1. Dissolved Tin values in Cans with Melon Cubes (in ppm)

Production dates	5/8/69		10/8/69		12/8/69		19/8/69	
Analysis date / Treatment	1 Month	6 Months	1 Month	6 Months	1 Month	6 Months	1 Month	6 Months
Heat Exhausting 10 min. at 90°C	80	126	27	38	38	167	281	300
Vacuum Exhaust in can 2 min. at 28" Hg	63	103	34	82	55	119	163	215
Vacuum Syruping in bulk 2 min. at 28" Hg	49	-	-	-	86	146	54	109

A special lacquer which did not affect the taste of this product was applied and is now being used succesfully.

Dehydrated Vegetables

High sanitary standards are obligatory for a successful food export program. Microbial counts of finished products are commonly used as an overall indicator for sanitary conditions in the food plant. In an investigation into factors affecting microbial counts of dehydrated onions we found that the counts depended on initial load and operating procedures. Proper washing of peeled and trimmed onions, exposing them to steam and dipping them in dilute salt solution prior to drying, reduced the microbial load significantly. Microbial counts as affected by processing conditions are demonstrated in Figure 4 and show a significant decrease of total and coliform counts during the process but a smaller decrease in mold count. Figure 5 shows the benifit of dipping the onions prior to drying into a 2% salt solution. Furthermore, the microbial count in the final product decreased during storage especially at elevated temperatures (25 or 30°C). (Furstenberg, 1973).

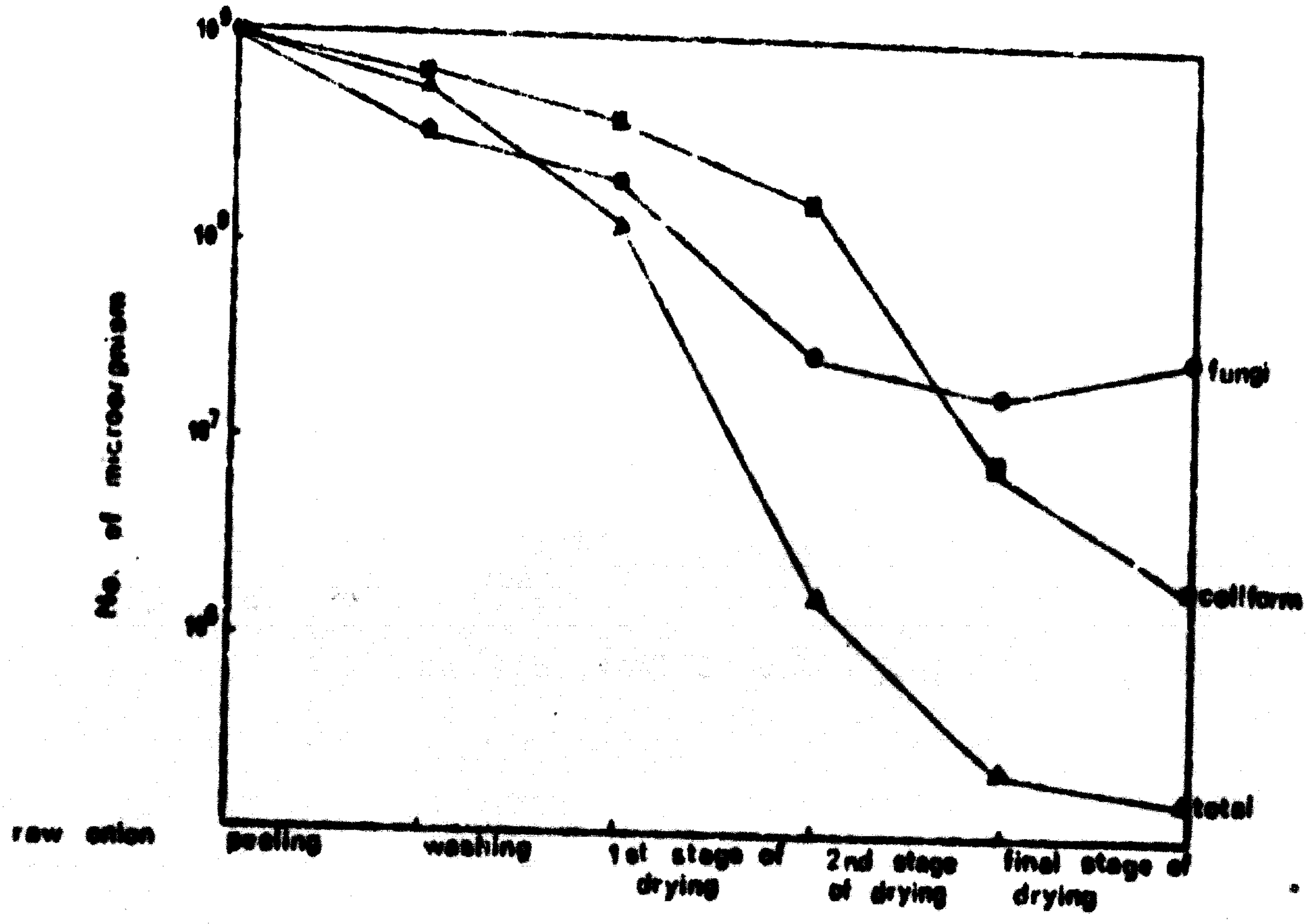


Fig. 4. Change of microbial count during various stages of onion dehydration.

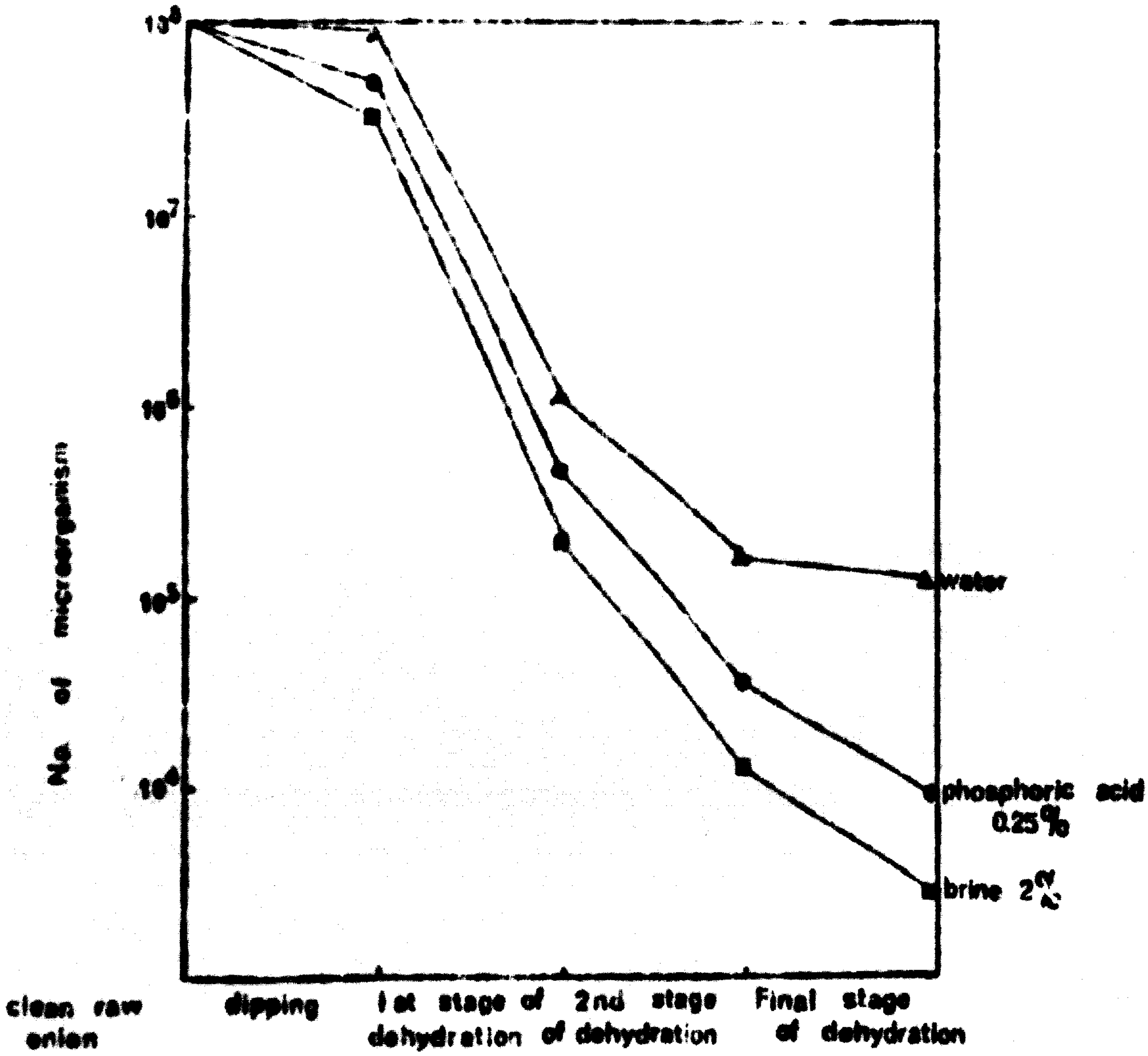


Fig. 5. Effect of dipping sliced onions into various solutions on number of microorganisms.

CHOICE OF OPTIMUM CONTAINER FOR PRODUCT

Evaluating the suitability of conventional and new types of tin plate and other coated metal cans, for existing and new products as well as revision of container specifications, are regularly called for. The main function of the container is to protect its contents, over a maximum period under prevailing storage conditions, without impairing the quality of the product or being affected by it.

Corrosion, i.e. tin and iron dissolution of the can, is an electrochemical phenomenon caused by the formation of an electric cell. This phenomenon is influenced by the nature of the product, types of steel base plate and tin coating, the presence of corrosion accelerators such as sulfides, sulfur dioxide, nitrates and oxygen, processing variables and storage conditions. The old criteria for evaluating corrosion or shelf-life of canned products,was to measure time required for first failure of cans in a test pack or time for 50% failure. These criteria are only indicators as to the shelf-life of the container but do not give any indication as to changes in product quality during storage. Product is often found to be unpalatable due to deterioration in storage while the can is still in good condition at the same time.

A better criterion for following the corrosion process in the can and determining shelf-life which is used today, is the time needed to reach a predetermined tin level. This value used to be 250 ppm tin, but recently authorities in many countries decreased this value to 150 ppm or even less.

The corrosion mechanism in the system tin can-acid food may be divided into 3 stages, namely:

1. A fast initial stage, where the oil and tin oxides are removed from the can body and tin dissolution starts.

2. Agradual dissolution of tin. At this stage the tin gives cathodic protection to the exposed steel. This is the critical stage which determines the shelf-life of the can.

3. Fast dissolution of iron and the residual tin. This stage is of little importance, since by this time the can has reached the end of its useful life.

Factors affecting corrosion in tin cans

a) Steel plate. The quality of the steel as determined by its chemical composition, its rolling, annealing and cleaning treatments before coating are important parameters and affect corrosion performance.

b) Tin coating. The methods of tin coating are used:

Hot dipped tinplate - This is done by dipping steel plate in a bath with molten tin. The plate receives same coating on both sides, but fluctuations of coating thickness on the plate are quite high.

Electrolytic tin plate - The coating of the steel plate is performed electrolytically. A better supervision of coating weight is achieved.

Differential tin plate - This is electrolytically coated plate with a different tin thickness on each side.

K - Plate - This is electrolytically coated plate which conforms to rigid performance tests and has superior corrosion resistance. Originally it was defined as plate made in an alkaline stannate bath instead of the normal acid Ferrostan process. The main characteristic of this plate is its superior tin iron alloy which is of even crystal size. K plate today is defined, irregardless of process, as plate having pickle lag values (speed of hydrogen evolution in HCl) of less than 10 seconds, iron solution values of less than 20 mg iron and average Alloy Tin Couple

(ATC) values of less than 0.05 $\mu A/cm^2$. The latter value is the most important one and measures the current flow between a standard pure tin electrode and the test sample, exposed to its alloy layer, with measurements being taken in grapefruit juice.

In a test pack with commercial grapefruit juice, K plates proved to be significantly superior to ordinary electrolytic plates with identical nominal coating weights but from different sources (Table 2). The ATC test was found to compare best with dissolved tin values in the grapefruit juice. In other experiments it was shown that this test was suitable for corrosivity evaluation of different media. (Landau & Mannheim, 1970).

Table 2. Properties of two types of tin plate and results of tin dissolution in a grapefruit juice test pack.*

Type	Source of supply	Nominal coating (lb/bb)	Actual tin coating (lb/bb)	Alloy layer (lb/bb)	ATC ($\mu A/cm^2$)	ISV (mg)	Pickle lag (sec)	Dissolved tin after 10 months at 25°C (ppm)	Dissolved tin after 10 months at 35°C (ppm)
Ordinary	A	1.00	0.994	0.072	0.177	29	9.25	128	166
Ordinary	B	1.00	0.974	0.081	0.118	32	14.5	106	160
Ordinary	C	1.00	0.980	0.083	0.092	25	11.5	99	142
K	D	0.75	0.758	0.114	0.046	12	3.5	92	125
K	D	1.00	1.096	0.098	0.054	7.5	5.4	86	111

* (Landau, 1970).

C. Nature of the product

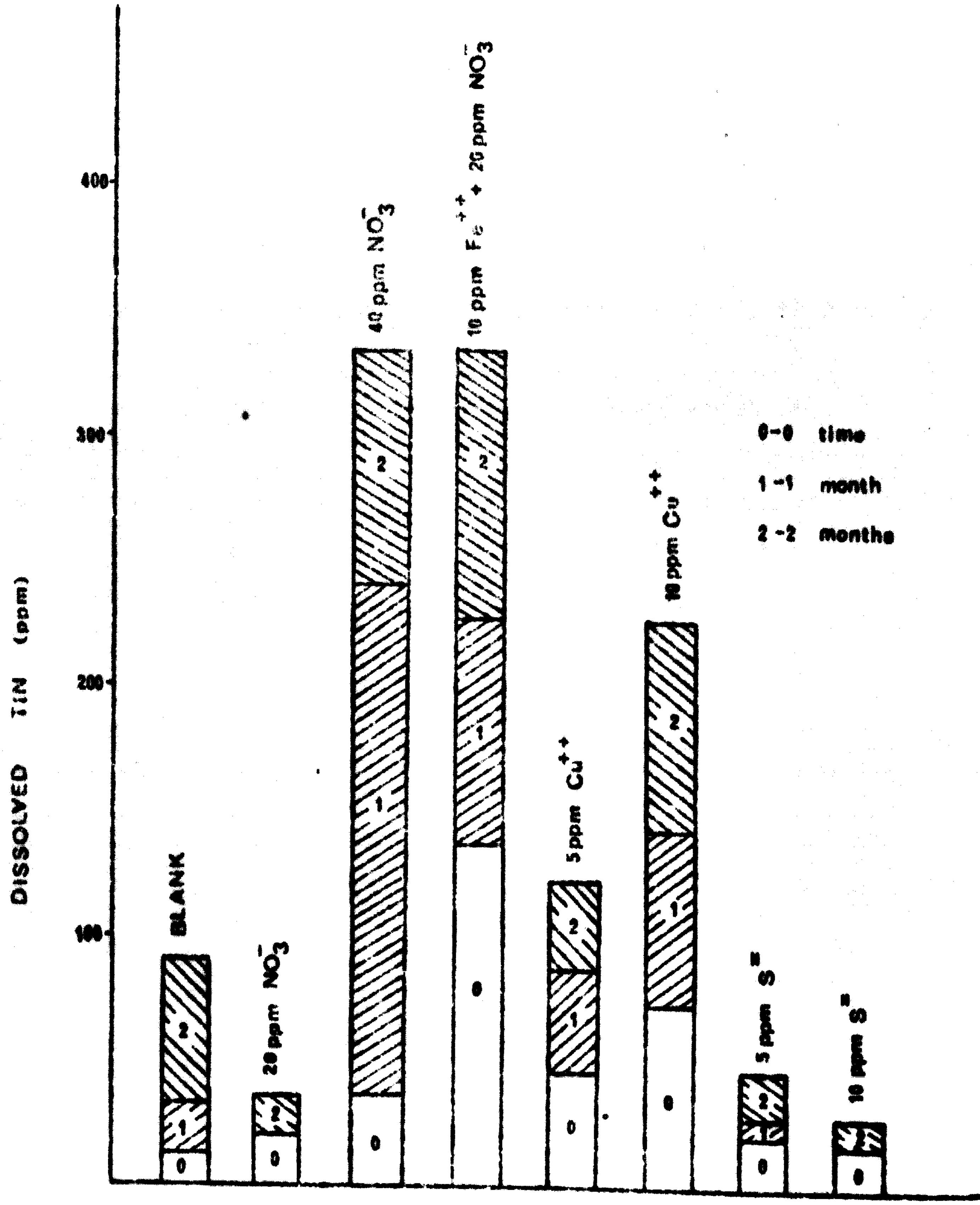
1. Acidity, pH, type of product

Acidity, pH and type of product affect the corrosion behavior of the can-product system. There is no linear relationship between pH or total acidity and the shelf-life of the can. Generally speaking, the lower the pH, the faster the corrosion process. However sometimes, a product having a high pH may be more corrosive than one having low pH (melons for example which have a relatively high pH are more corrosive than citrus products). The corrosion behavior is also dependent on the type of the anion. In sulfuric, acetic, malonic and succinic acids the tin is cathodic to the iron, whereas in oxalic, citric, lactic and tartaric it is anodic. The presence of tin ions in solution has a retarding effect on corrosion of the can.

2. The effect of corrosion accelerators

Corrosion accelerators or depolarizers are oxidized substances, which are easily reduced by the hydrogen evolved in the can due to their high reduction potential. These materials are inhibiting polarization at the tin plate - thus accelerating corrosion (Cheftel, 1954). Many food products contain natural or added depolarizing substances. These include spray residues like copper or sulfides, nitrates from fertilizers or the water or sulfur dioxide from sugar or other sources. Effect of some of these additives is shown in Fig. 6.

Fig.6 DISSOLVED TIN IN MELON CUBES WITH VARIOUS ADDITIVES.



In studies made in our Laboratory (Saguy et al. 1977) threshold values for nitrate ions as affecting corrosion were found. With 3mm headspace the threshold value for tin dissolution was 6 ppm nitrate, while with 30 mm headspace this threshold value went down to 2 ppm (Fig. 7).

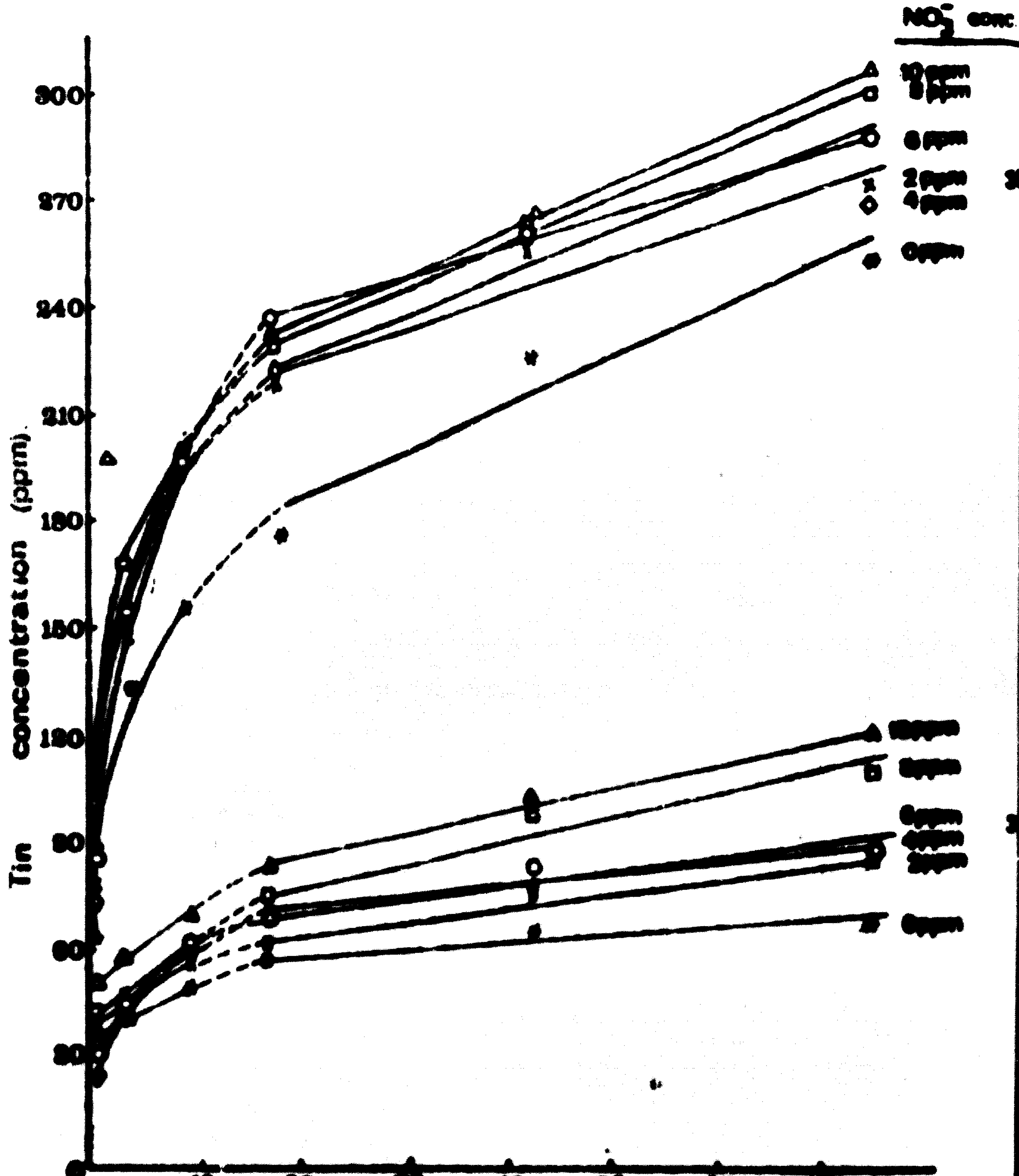
d. <u>Processing variables and storage temperature</u>

Processing methods of the product and presence of oxygen are extremely important in governing the products' shelf-life. Oxygen in the canned food may be present in the headspace, dissolved in solution or in the product tissues. This is a most important factor in corrosion acceleration and therefore filling, exhaustion and dearation processes are of prime importance. Deaeration, headspace and proper cooling were shown to affect quality of final product, such as grapefruit juice (Bakal & Mannheim 1966) Fig. 8. Deaeration had the most inhibiting effect in regards to corrosion and juice quality. A large headspace had the most unfavorable effect on corrosion, color and taste (Fig 9). Processing under optimal conditions was found to have a significant effect on shelf-life of product and corrosion inhibition.
Storage temperatures have a pronounced effect on product quality and can corrosion. Each increase of 10°C in storage temperatures about doubles rates of reaction like browning and corrosion occurring in canned products.

<u>Lacquered cans</u>

The reasons for applying lacquer coatings to food cans are as follows:

1. Prevention of blackening of cans due to sulfide staining. This blackening originates from sulfur-amino acids present in foods like fish, meat, peas and corn.



Dissolved Tin content as a function of storage time and NO_3^- concentration.

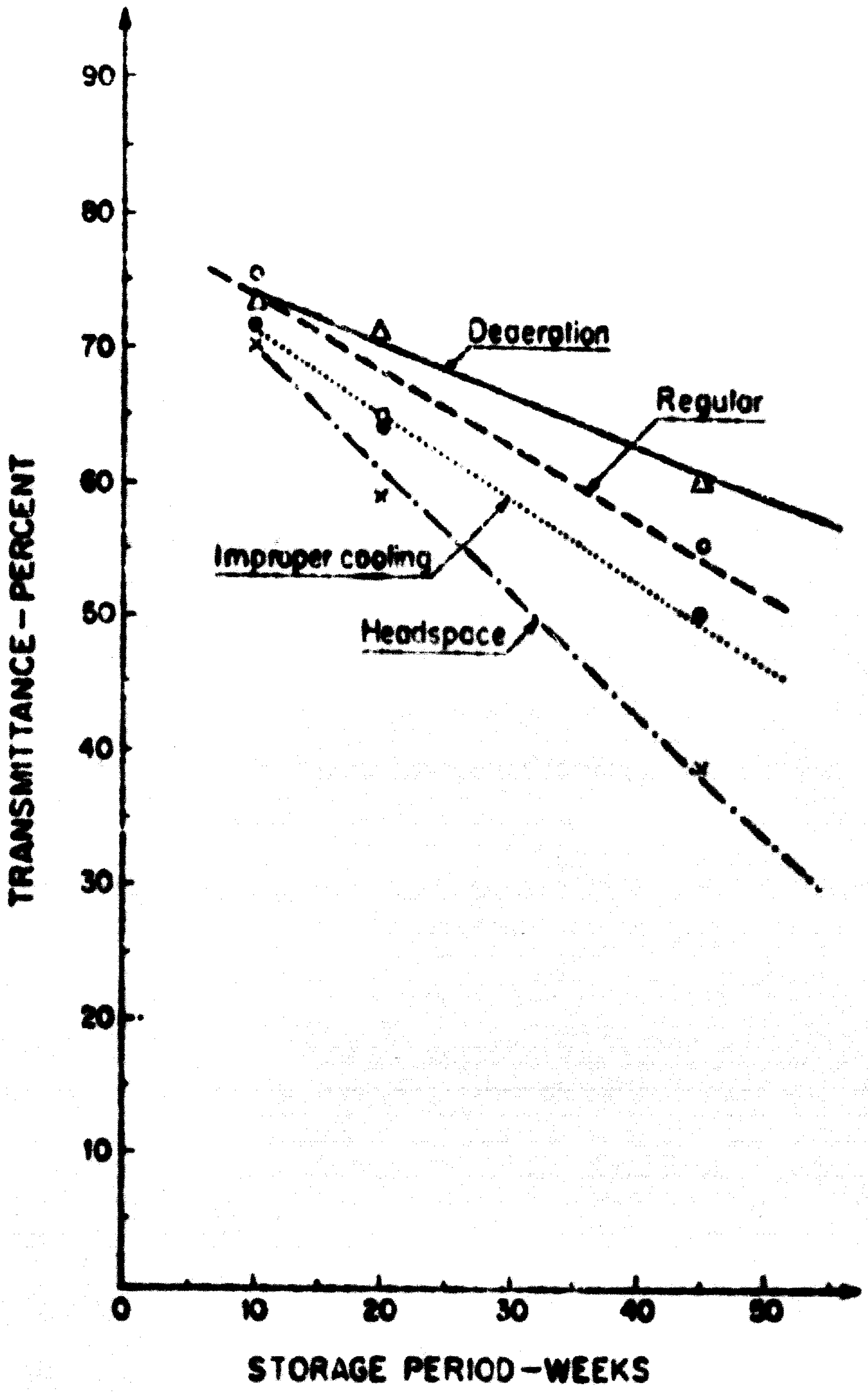


Fig. 8. Percent transmittance of differently treated grapefruit juice during storage at 35°C.

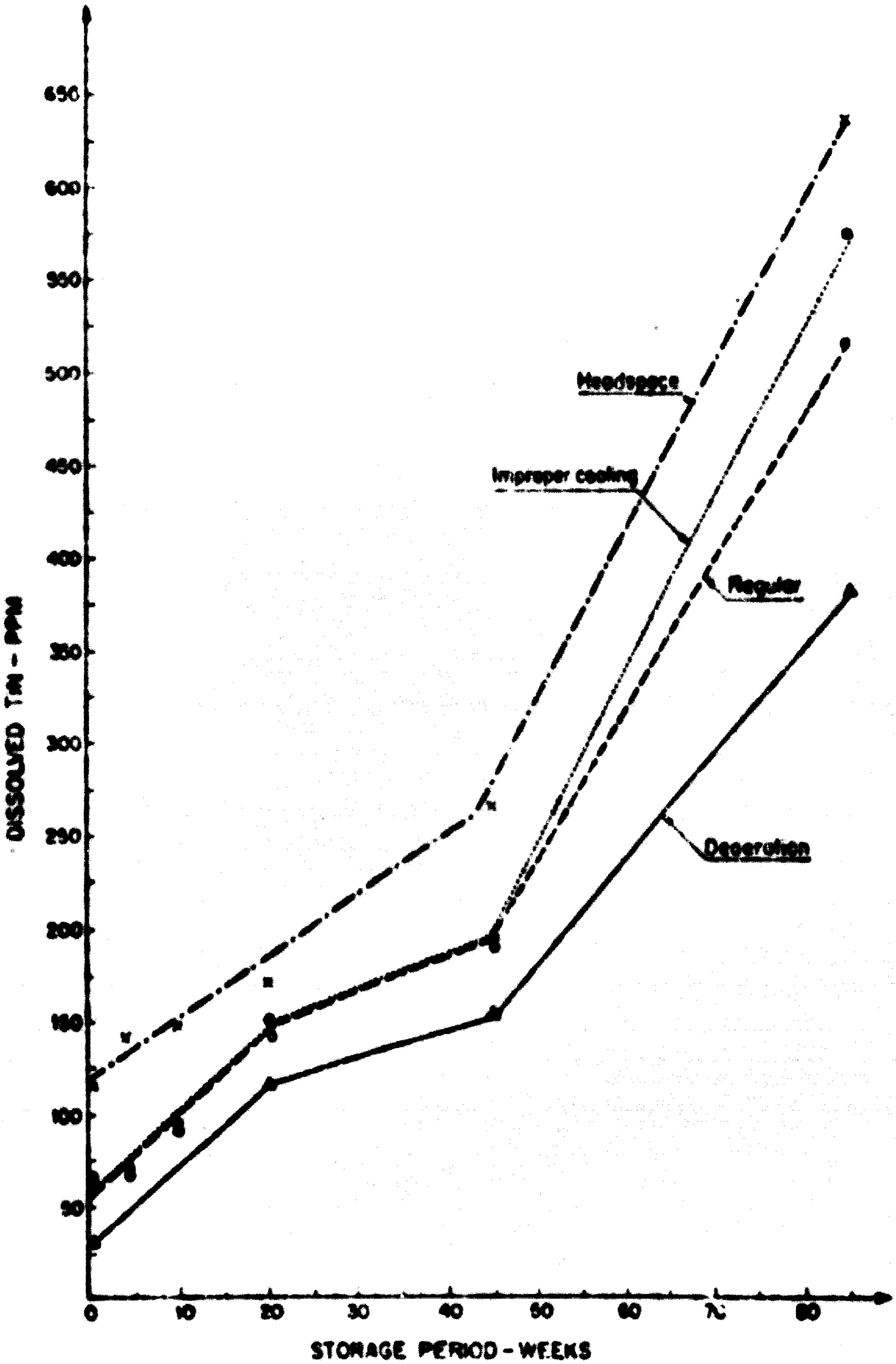


Fig. 9. Increase of dissolved tin content of differently treated grapefruit juice during storage at 35°C

2. Prevention of color change of product in plain tin cans due to reduction of color by hydrogen evolved in the can, like in the case of anthocyanin pigments in plums, or strawberries.

3. Prevention of corrosion in acid food products with the aim of reducing dissolved tin content during storage.

Generally speaking the lacquer serves as a physical barrier between the product and the can,thus preventing the interaction of product with the tin plate.

Properties of lacquers

Lacquers are made of natural and synthetic resins and because of their appearance, are often called "golden lacquers". Table 3 shows the properties of lacquers commonly in use in the canning industry today.

Lacquers have to be applied to the tin plate prior to can making and withstand the conditions of can production. They must adhere to the tin plate, be odorless and taste-free, free of toxic materials, and withstand thermal treatments given to the food products. Ion penetration through lacquers should be minimal.

Defects in coating may be caused by small craters and impurities in the sheet, scratches on the sheet, and damages during can manufacturing processes. These defects may be reduced or eliminated by applying a double lacquer coating.

The use of lacquered cans for citrus products in order to reduce the dissolved tin content was investigated (Mager, 1973). Tin contents of 30-50 ppm and iron contents of 3 - 8 ppm were found in orange juice after 180 days of storage at 25°C. This demonstrates that tin content in a corrosive food like citrus juice may be reduced by using lacquered cans. On the other hand the problem of choosing the right lacquer to prevent appearence of off-tastes and browing is

Table 3. General properties of typical can-lining resins[a]

Rating Scale: 1 = good ; 2 = fair ; 3 = poor.

Coating-type resin	Flavor	Flexibility	Adhesion	Color	Cost	Solder damage resistance	Sterilisation resistance	Acid resistance	Alkali resistance
Acrylics	1	1	1	1	3	1	1	1	1
Alkyds	3	2	1	2	1	2	2	2	3
Epoxy-amine	1	1	1	1	2	1	1	1	1
Epoxy-ester	2	1	1	2	2	2	1	1	2
Epoxy-phenolic	1	1	1	3	2	1	1	1	2
Oleoresinous	2	1	1	2	1	2	1	1	3
Phenolic	2	2	1	3	1	1	1	1	3
Polybutadiene	2	2	1	2	1	1	1	1	1
Vinyl	1	1	2	1	3	3	2	1	1

[a] Modern Packaging Encyclopedia 1970.

still not finalized. It is interesting to note that in organoleptic tests the tasters always prefered juices having about 20 ppm tin to juices without any tin.

External corrosion

External corrosion is observed very often, on the body of tin cans and on their ends. Rust stains even penertate through labels sometimes.
The limiting factors for protecting the tin cans against external corrosion are as follows:

1. The coating is discontinuous and tiny pores in the coating are forming electric cells, on which drops of water serve as electrolytes.

2. The tin coating maybe scratched and damaged during can production.

3. During processing in the food plant, the cans may be chemically attacked by active materials.

Conditions necessary for corrosion are: moisture, acidity or alkalinity, or the presence of electrolytes. The rate of corrosion is extremely slow at dryness. External corrosion is the result of an improper process or poor storage conditions. Factors which affect corrosion during processing are summerized below:

1. Sterilization process

   a) Dirty cans in the autoclave.

   b) Food remains and rust in the autoclave.

   c) Water saturated with oxygen and air in the autoclave.

2. Steam and water quality

   a) Alkaline steam from salts used in the water softening system.

   b) Scale in the steam boiler, pipes and autoclave.

   c) Corrosive salts in cooling water and an execcssive level of cholorination.

   d) Alkaline or acid water.

   e) A high level of detergents in washing water.

3. Improper drying of cans prior to labelling and presence of moisture in carton.

4. Cans closing and transportation

   a) Dust and dirt on cans especially in industrial cities and in humid areas.

   b) Condensation of water on cans during storage or transportation due to sudden changes in temperature.

5. Labels and glues

   a) Labeling on wet cans as mentioned before.

   b) Labels and glues containing corrosive materials or reacting with corrosive materials.

To overcome external corrosion, precautions must be taken to avoid all the above mentioned parameters. Cans should be dried by air or dry steam. Storage area should be free of dirt and dust, and humidity should be kept low. Labels should not contain more than 0.05% chloride as sodium chloride, and no more than 0.15% sulfates (as sodium sulfates). Inhibitors in the washing water may be used, Thus preventing corrosion by either coating the can with a thin oily film, or reacting with the tin oxide to form a corrosion resistant layer.

A comparison between two corrosion inhibitors, soft water rinsing and steam spraying prior to drying as tested in a standard condension cabinet, are shown in Table 4. (Mannheim & Mager, 197[illegible]).

Table 4. Effect of corrosion inhibitors on 43 oz tomato juice cans in condensation cabinet.

Treatment \ days	No. of spots on cans			
	2	5	10	20
PAG CHELED 610	3	12	18	Pulverulent rusting on can ends
CHIMSOL RP-4	6	13	Rusty	Rusty and pitting
Soft water rinsing	8	12	Slightly rusty	Pulverulent rusting
Steam spraying	2	5	12	18

Steam spraying proved to be best of all treatments apparently due to the combined effect of soft water rinsing (the condensed steam) with drying. Use of inhibitors was less beneficial and in addition their application requires careful adjustment to water salinity.

Improved outer packaging like cartons which prevent moisture penetration and shrinkable films are now being used.

UTILIZATION OF BY-PRODUCTS

The efficient utilization of waste products into useful applications is a necessity not only for economic reasons but also from the ecological point of view. In many countries factories are being fined for polluting streams with high B.O.D. effluents and disposal of solid wastes has also become a difficult and costly problem. A few examples will serve to illustrate this point.

In normal citrus juice extraction procedures only about 50% of fruit is turned into juice,remainder being peels, seeds, pulp etc. Unless these so called "wastes" are utilised in some fashion they may become a great burden to the processor or environment around the factory. The most common solution to this problem is to press the peels and obtain "peel juice" and dry the remaining peel for cattle feed. The peel juice can either be concentrated to molasses and also be used as a feed additive or fermented to alcohol or vinegar. Another important outlet for peels is their utilization for pectin manufacture,however, this is a very expensive and highly skilled operation and should only be attempted after thorough feasibility studies.

Some other products which can be made from peels,besides oil, are the flavonoids hesperidin or naringin, citrus colors, etc. It is estimated that about 160 products could potentially be produced from citrus fruit. In actual practice only about 40 products or 25% of this potential are being made commercially at present leaving large possibilities for future expansion.

The better utilization of wastes from tomato processing plants is another example for this topic. Tomato wastes are between 5 to 8% of this raw material and are composed mostly of seeds and peels. The seeds are relatively rich in oil and contain about 6-9% on a wet basis (60-70 moisture) or 18-20% on a dry basis (10% moisture). The composition of this oil is very similar to that of soya bean oil and it could be used as an edible oil. (Mannheim et al. 1972).

The problem of dairy waste has been a concern of the dairy industry for many years not only for reasons of pollution, which is a recent concept, but because of the losses in product. In ordinary milk bottling plants milk losses are estimated to be 1 to 2% arising from cleaning losses, leaking packages, burn-on in heaters etc. The greatest losses in milk solids are in butter and cheese making, being up to 50% in the latter product. It is estimated that still today 70-80% of cheese whey in the world is discarded into sewage or streams or at best used as hog or cattle feed. However, whey can be turned into profitable products as shown in Table 5.

Table 5. Processes for whey utilization.

Process	Product	Use of product	Use of residue
Spray drying	Whey powder	Animal feed	No residue
Heating, filtering	Whey protein	Soft cheese	Lactose manufacture (or yeast fermentation)
Crystallization	Lactose	Drugs, baby food	Animal feed
Ionic exchange	Demineralized whey	Baby food	No use possible
Electrodialysis	"	"	"
Reverse osmosis	Whey concentrate	Further processing	No residue
Ultra filtration	Whey protein	Not yet developed	Lactose-manufacture
Gel-filtration	"	"	"
Yeast fermentation	Protein concentrate	Animal feed	No residue

Above mentioned products are all made commercially today and include only a small portion of products which can be produced as in the case of citrus wastes. Other potential uses include a whole range of fermented products such as whey vinegar, beer or alcohol as well as products such as Vitamin B_2 or B_{12}, immitation egg protein, soft drinks, dough improvers in breads etc.

Spice plants are an important crop in many developing countries and usually directed for export. There is considerable waste in these crops resulting from field damage, rot or dirt. In these cases the spices are unfit for human consumption and are useless. Such spices and similar plant materials can however serve as raw materials for high value oleoresin production. Oleoresins are prepared from spices or herbs by extraction with a selected organic solvent which is later completely removed from the extracted product. Oleoresins, therefore, contain all the flavoring and coloring principles in the raw material and are very clean, from the sanitary point of view, stable and easy to use. (Mannheim et al, 1972), have shown that a highly colored oleoresin could be made from Capsicum and red bell pepper wastes in a dehydration plant.

SPECIAL PROBLEMS

In any industry production failures may occur. they should be anticipated and precautions must be taken to prevent them. In the food industry these failures include presence of foreign bodies in product, swollen cans due to microbial spoilage or corrosion , occurance of off-flavors from unknown sources, peeling of internal lacquer, etc. Failures may be reduced to an acceptable minimum by using modern quality control techniques and updating know-how by close contact with new methods and developments.

Quality Control

Products designated for export must conform to international standards and to those applicable in the country which imports the merchandise. Quality control procedures should be adopted and include:

(a) Control of quality of raw materials including spray residues.

(b) Control over auxilliary and packaging materials.

(c) Control of production conditions.

(d) Inspection of final product.

(e) Conclusions from above and feed-back methods for immediate corrections.

Above procedures should be adopted in each plant and be organised in a special department. Written procedures should be formulated and should include instructions as to when production is stopped and at which quality level a product is rejected for export.

In addition to inplant quality control, governments must exercise centralized control over all plants. The central organisation should advise in setting up procedures, inspect plants periodically, take samples for checking reliability on in-plant quality control, advise on foreign laws etc. Often it may be necessary to set up special testing facilities and procedures, make surveys etc.

Research and Development

Any industry must have at its service research and development facilities. In developing countries industries are usually too small to afford such laboratories individually and therefore a central organisation is adviseable.

Research activities concerning foods should be divided on disciplinary lines as well as by commodity subjects. This is required in order to provide a sound basis for the work to be carried out, even though most work should be of an applied nature.

The disciplinary areas of research should include: biochemistry, microbiology, analytical chemistry, basic food technology and engineering and packaging. The commodity fields should be set up according to the priorities of the local industry.

The research program should be set up on a yearly basis and include medium-range and long-range projects.

In addition, the research and training center should provide the industry with extension services as following:

1) Information on new developments (local and worldwide).
2) Seminars and short courses on topics of interest to local manufacturers.
3) Aid to experts in the industry in process and product development.
4) Trouble shooting including solving spoilage problems, giving expertise opinion, etc.
5) Assistance in planning, erection and running-in of new factories.
6) Assistance in surveys relating to the industry.

S U M M A R Y

The development of a food processing industry for export depends on the availability of suitable raw materials, packaging materials, utilities, transportation and trained manpower. In order to ensure the quality of the agricultural raw material it is necessary to produce them as industrial crops. Direct contact between grower and producer is necessary and detailed specifications and acceptance porcedures are recommended.

While process equipment and techniques can be imported from abroad their adaptation to specific needs is often called for. Process chosen should be up-to-date but should not exceed requirements as regards automation and sophistication. The sanitary tin can is still the most widely used container for processed foods. Careful specifications should be worked out for this item and they should be reevaluated periodically. In order to assure maximum shelf-life, care must be taken to prevent both internal and external corrosion by using all available means. These include reducing concentration of corrosion accelerators, choice of proper container composition and coating, careful adherence to good processing practices and proper storage conditions.

Efficient transformation of wastes into useful by-products is important from the ecological as well as economic point of view. This can be done by turning wastes into feed products or by recovering some minor constitutent for foods.

Rigid quality control procedures are required to achieve high and even quality of products designated for export.

Finally, industry must have close ties with research organizations for information on new developments for process and product development, trouble shooting and assistance in planning new ventures.

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