TIME-TEMPERATURE MONITORS FOR FRESH AND FROZEN FOODS

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To preface my presentation today, I would like to state the following proposition, which is open to challenge at any time:

> Any system or tool designed to provide evidence of loss of quality in perishable foods must, at least, integrate the effects of both temperature and time for the entire storage life of that product.

At the present time there are basically two systems which are used, in various forms, to assure purchasers of perishable foods - and these purchasers include food distributors and retailers, as well as consumers - that quality has been adequately protected in the products they buy. The first of these is spot temperature checks during selected phases of distribution. These are essentially meaningless and can be grossly unfair. Spot temperature checks neglect the time factor, and can in no way provide a reasonable basis of judgment as to the adequacy of handling at the moment at which the check was made. By their very nature, spot checks can only measure a very minor proportion of the goods flowing through distribution channels.

The second system, which has enjoyed increasing popularity (or unpopularity, depending upon the hat you wear) in recent years as a result of increased consumer awareness, is open dating - the printing on the package of the date beyond which the product should either not be purchased or not sold. On the surface, open dating appears to be in the league with Mom and apple pie - who can knock it? It is definitely one way of keeping consumers better informed and who will deny their right to more information? For products not requiring controlled temperature storage conditions, whose shelf life is so brief or so long that wide variations in temperature will not appreciably affect its quality, open dating is a valid form of guidance for purchase and use. For perishable products, however, it may not only be meaningless, but can often be directly misleading. The reason for this is that it completely neglects the essential element of temperature. One leading spokesman for the food industry, when confronted with the problem of putting an open date on his perishable products, stated that he would probably have to go along with it, but might just as well print his grandmother's birthdate on the packages for all the good it would do. Open dating can only be meaningful if perfect or near-perfect temperature handling is afforded perishable products and this, while a goal of the food industry, will take some time to accomplish. The push for open dating for perishable products is, therefore, a definite case of putting the cart before the horse.

For many years, various degrees of attention have been given to the perfection of some kind of device which could be placed on packages or containers of perishable foods to give external evidence of

what had happened to those products during distribution. To date, some sixty patents have been issued for various kinds of indicating devices which would, in different ways, attempt to show when breakdowns in temperature protection have occurred. Few of these devices have enjoyed any measurable degree of acceptance, however, for the simple reason that they either do not work or do work, but are economically or practically unacceptable.

In the last 2 - 3 years, attention has been focused increasingly on the benefits that could occur to both buyers and sellers of perishable foods if the right kind of external indicating device could be found. The topic of temperature indicating devices has been studied or taken up in these last years by such diverse groups as the American Frozen Food Institute, Consumer Union, The Institute of Food Technologists, the State legislatures of New York and New Jersey, the United States Army and some large supermarket chains. Judging from the activities of groups such as these, as well as from opinions expressed throughout the food industry, it appears that there is currently definite interest in a temperature indicator for use in monitoring the handling of perishable foods if it can fulfill certain basic requirements. In general, these requirements are as follows:

1. The indicator must be economically feasible. The cost of the indicator itself, plus any added expenses which result from the incorporation of a monitoring system into distribution practices, must be such that neither the food industry nor the consuming public is burdened with expenses which are in excess of value received.

2. It must give a clear signal whose implications are clearly understood by all handlers of the products who will be required to interpret and act upon this signal.

3. It must protect buyer's interests; that is, it must show that a sufficient amount of acceptable quality remains at the time of purchase for his subsequent normal use.

4. It must also protect sellers' interests by not in any way condemning products which actually do have sufficient quantities of acceptable quality remaining in them. Failure to do this would cause unnecessary and unacceptable waste of food resources.

5. Its function must, directly or indirectly, relate to the quality of the products which it is monitoring. This implies the necessity of functionally combining both critical factors of temperature and time.

6. It should ideally be self-policing; that is it should enable buying or acceptance decisions made on the basis of its signal to constitute, by themselves, an adequate control mechanism. It should not require an extensive organizational apparatus to implement or police its use.

7. It should permit corrective action to be taken during the distribution process so that product waste can be minimized. In other words, the indicator message should not be a suicidal one - "when the spot turns color the package will self-distruct" or, more realistically, the indicator signal should not require immediate removal of the product from further distribution. Instead, it should be such that distribution can be accelerated so that the product will still reach

the consumer in acceptable condition, again preventing unnecessary food waste from occuring.

8. Lastly, the indicator should be reliable, and given the importance of its function as outlined above, this pre-requisite requires no comment.

Since 1970, we at the i-point Company in Malmö, Sweden have been working to provide a temperature indicator which would meet the requirements just outlined. This has been a long and intricate development process which has led us into completely new areas of biochemical technology. We now have a temperature monitoring instrument which can provide a valuable service to all of us interested in maximizing the retention of quality in the perishable food products we sell or consume. We have called our indicator the i-point TTM, or Time/Temperature Monitor.

It is a self-adhesive label designed to monitor the temperature handling of perishable products and gives warning if unsatisfactory temperature conditions occur.

Although the largest potential area of use for this device is in the distribution of frozen, fresh and refrigerated food products - it can also be used for many other types of products which must be handled at controlled temperatures.

When we became engaged in this project we realized there were several standards this device must meet if it were to be practically applicable.

It must be -
- Reliable
- Accurate
- Small
- Inexpensive

And it must have a message which could be -
- Clearly Understood

To be effective it should also -
- Integrate both the length and degree of all temperature exposures

It is well to point out that the idea of a monitoring device to be used for perishable products is not a new one.

In the United States alone, over 50 patents have been granted for various types of temperature indicators.

None has met with commercial success, however, because none has been able to meet the qualifications just mentioned.

They simply have not been able to do the job.

What exactly is the job to be done?

We discovered that this is not a question to be easily answered and that is one of the reasons why it has taken us six years of intensive research and development work to bring forth the first generation of i-point TTM.

In our opinion the best way to show the deterioration of biological products is by using enzymatic reactions.

They are in this respect superior to purely chemical or physical indicating methods and devices.

The reaction of i-point TTM is based on enzymatic degradation giving rise to colored end products.

As an example, this type is based on change in PH caused by enzymatic activity.

This device consists of two pouches, one containing the enzyme and the other the substrate.

In the enzyme part we also have liquid PH indicator.

The reaction is simply started by applying pressure on the package whereupon the seal between the two pouches is broken and their contents mixed.

When stored at ideal temperatures, the reaction proceeds very slowly.

As temperatures change, so does the velocity of the reaction - slower if the temperature is lowered and faster if the temperature is increased.

Thus, a cumulative effect of time and temperature is obtained.

When predetermined time/temperature limits have been reached the device reacts by changing color, clearly and irreversibly - blue to yellow in this case.

In looking at applications for our time/temperature monitor, we found several valid reasons for concentrating our early efforts in the area of frozen foods:

1. There is a great deal of information publicly available concerning the effects of temperature on the storageability of frozen foods.

The pioneer contributions in this area were the studies of Van Arsdel and others at the USDA Western Regional Research Laboratory in the 1950's.

These studies resulted in the time/temperature tolerance hypothesis which have become basic guidelines in questions of frozen food stability.

2. A second reason was that early during our development work, the American Frozen Food Institute, the major organization of frozen food processors in the U.S. became interested in time/temperature monitors.

We have cooperated closely with this organization and individual member companies in their efforts to evaluate possibilities for application of monitoring devices within the frozen food industry.

3. Thirdly, we found that i-point TTM could function effectively in the entire temperature range in which frozen foods are handled, or mishandled, and it did, indeed, respond in accordance with the TTT conclusions.

The essential elements of these time/temperature studies are:

1. Quality loss in a frozen product is proportional to the integrated accumulated effects of both time and temperature.

2. The rate of quality loss will increase as storage temperature increases and decrease as temperature decreases.

3. All quality losses are cumulative and irreversible.

4. All temperature effects are commutative - they have the same result on product quality no matter when they occur during the life of a product.

These qualities are true of most food products, frozen as well as refrigerated and obviously also of many other time/temperature sensitive products as live viral vaccines and many pharmaceutical products.

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