CONSUMER PACKAGING OF VEGETABLES

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What is meant by consumer packaging or prepackaging, whichever you may choose to call this new industry? Retailers have been weighing, bagging, or otherwise packaging vegetables ever since the first markets were established. The "pre" was attached to packaging to designate the new merchandising method in which the actual packaging operation was performed before the produce entered the retail store. Consumer packaging is another term referring to the preparation of a unit which has been previously wrapped in convenient form for the consumer to select and carry home with a minimum amount of handling. Prepackaging or consumer packaging also indicates that the produce in the package has been trimmed, washed, or otherwise prepared for cooking or eating.

The beginning of consumer packaging is very hard to trace. Potatoes and onions have been sold in various small containers for many years. The R. T. Brown Cannery at Springfield, Mass., using the name of Farmer Brown, made one of the first attempts to market consumer units of spinach wrapped in transparent film. At the present time, Farmer Brown is packaging eight or ten cars of mixed vegetables per week.

In Los Angeles, Cal., the Sunny Sally vegetable growers started packaging spinach in 1939, and in 1946 sold between 5 and 10 million consumer units in cellulose acetate bags.

Since 1945 the Ohio State Agricultural Experiment Station in cooperation with the Great Atlantic and Pacific Tea Company has been conducting the much publicized Columbus experiment. The vegetables are all packaged in the A & P Company warehouse in Columbus and sold in ten supermarkets equipped with refrigerated display cases. The emphasis in this study has been placed on consumer acceptance and the reduction of spoilage and waste.

During the last few years the consumer packaging of fresh produce has attracted widespread interest. All types of trade and scientific journals, as well as newspapers, are publishing articles on the subject. Pre-Pack-Age, a new monthly trade journal devoted to modern methods of packaging and merchandising fresh foods, started publication in September of this year.

There are several reasons for this increasing public interest. Leaders in the fresh produce industry estimate that 25 to 35 percent of all the edible produce grown in this country is wasted somewhere along the line between the farm and the consumer. Our wasteful handling methods are particularly bad in the present period of world food shortages and high food costs which are partly attributable to the high cost of distribution. The housewife of today has been educated in terms of food quality, grades, balanced diets, including fresh vegetables and the methods for preparing the most tasteful and nutritious meals. She has also learned how to avoid the long hours of toil in the kitchen each day which were demanded by the old methods of food preparation. Thus, we find an increasing demand for fresh produce prepared in advance for cooking or eating.

Many problems have arisen in connection with this new method of merchandising and research projects are being initiated by government agencies and many industries in an attempt to find the answers. For instance, authorities differ as to whether the packaging should be done at the shipping point or at the terminal market. Since Congress passed the Research and Marketing Act in 1946 (Public Law 733) new emphasis has been placed on marketing research by Federal and State agencies. Consumer packaging studies already being conducted by the Florida Agricultural Experiment Station are being expanded under this new law.

Before prepackaging can be successful there are a considerable number of basic laboratory tests which must be made with the great variety of packaging materials on the market. For example, 41 different standard types of cellophane film are being manufactured by a single company. In addition to cellophane, the following films have been used for food packages: Pliofilm, Vinylite, cellulose acetate, ethyl cellulose, Vitafilm, and polyethylene.

Rapid progress has recently been made in the manufacture of new plastic, paper, and synthetic rubber films and packages. The raw materials and methods of producing the various films are quite different. An outline of the manufacturing process for cellophane will show not only the composition, but the possible variations in the process which result in very different physical properties of the film.

Cellophane is regenerated cellulose made from cotton, straw or wood. The highest quality cellophane is made from cotton, but the bulk of the supply comes from wood pulp. Pieces of pulp wood are steeped in sodium hydroxide solution, cut into fine pieces, then treated with carbon disulfide to produce cellulose xanthate. This material is mixed with a dilute solution of sodium hydroxide and aged for several days under a high vacuum to remove all air bubbles. This viscose liquid is then ready for making cellophane sheets, viscose rayon thread, or cellulose sponges. In the manufacture of cellophane, the viscose is forced through a long narrow slot which is immersed below the surface of an acid coagulating bath. The resulting film is run through a tank containing a dilute glycerine solution or other softening agents, and then dried. This film is not moistureproof or heat-sealing. A coating of wax, plasticizer, or resin must be applied in a very thin layer on one or both sides to reduce the moisture-vapor transmission and provide a means for heat-sealing. The common heat-sealing and moistureproofing coatings have poor adhesion to the cellophane in the presence of water. Another treatment, called anchor coating, is necessary when the film is made for packaging wet materials.

Pliofilm is made by treating rubber with hydrogen chloride to form rubber hydrochloride. Lumarith is cellulose acetate made from wood or cotton cellulose treated with acetic acid and acetic anhydride. Vitafilm and Vinylite are polymerized plastic resins. The Vitafilm is polyvinyl chloride and the Vinylite is a copolymer of vinyl chloride and vinyl acetate made from ethlene and acetylene gases derived from coal. Ethyl cellulose is made by treating cellulose with sodium hydroxide and ethyl chloride. Polyethylene consists of long chains of methylene groups formed by polymerizing ethylene gas under high pressure and high temperature.

In addition to the choice of packaging material, the type and size of the packages are also very important. Some vegetables are individually wrapped. A head of lettuce, an ear of corn or a stalk of celery with the tops trimmed may be loosely sealed in cellophane or stretch-wrapped in pliofilm. Stretch-wrapping is a technique whereby the Pliofilm is heated momentarily to a temperature of about 300° F. and the vegetable is pushed into the elastic film and tightly sealed. Bunch wrapping is applicable to such crops as carrots, green onions, asparagus and broccoli. The wrapper is applied directly to a standardized group or weight of vegetables. Transparent bags are used for quite a variety of items such as green beans, spinach, salad mixes, peppers, and shelled peas and lima beans. Certain paper manufacturers are selling paper bags with a transparent film window in the side. Window boxes are made with a transparent window sealed in the top of the box as is commonly used for tomatoes. Over-wrapped trays or boats are made by wrapping film completely around a card-board container with 2, 3 or 4 sides. This type of package is suitable for cauliflower, broccoli, green beans, radishes, tomatoes and sweet corn. Fully transparent plastic boxes have recently been placed on the market, but they are rather expensive for use as a vegetable package.

The physical properties of a particular film or type of package will largely govern its use as a packaging material. The degree to which a packaged vegetable is visible has been found important. In past years the housewife used her senses of sight, smell, and feeling in picking out her vegetables from open produce counters. When these vegetables are placed in an entirely closed package, the average buyer wants at least partial visibility. Varying degrees of transparency are inherent properties of the various films. Some are very clear, while others are slightly cloudy or yellow. Some types of films are clear when dry, but turn cloudy or milky white from contact with water on the outside of the package or water vapor on the inside.

The permeability of a film to the respiratory gases is very important in determining the composition of the atmosphere inside the package, which in turn influences the storage life and quality of the vegetable. It should be emphasized that vegetables in consumer packages are still living as contrasted to vegetables that have been killed by blanching, cooking, freezing, or drying. After the vegetable is harvested such metabolic processes as respiration and transpiration continue at a rate controlled by the environment. The ideal handling conditions will slow down these processes as much as possible without causing death and subsequent rapid deterioration. Very little change will take place in the fresh vegetable if it can be held at temperatures just above the freezing point. The loss of carbohydrates and vitamins by enzymatic action and oxidation will be reduced by low temperatures and a low supply of oxygen in the package. During normal respiration the carbohydrates are united with oxygen and the end products are carbon dioxide and water. If the film is not permeable to the intake of oxygen and release of carbon dioxide, the available oxygen will be used and pressure built up from excess carbon dioxide. The ideal film for most vegetables, according to Plantenius[1], would be one which maintained an oxygen concentration of 3 to 5 percent within the package. When the oxygen content drops below 3 percent anerobic respiration occurs with the production of alcohol and bad odors and tastes. An exception was found by Scott[2], who packaged snap beans and found that atmospheres of .4 and .7 percent oxygen and over 25 percent carbon dioxide produced no deleterious effects in 7 days. Instead, there was less discoloration and loss of Vitamin C in these packages of beans than in the more permeable packages.

According to various authorities, the films with the greatest permeability to respiratory gases are ethyl cellulose, cellulose acetate, non-moistureproof cellophane and unplasticized Pliofilm. When the moisture proof coating is applied to cellophane or a plasticizer added to Pliofilm the gas permeability is greatly reduced. When low permeability films are used, the film manufacturers recommend punching a hole in the package for ventilation. Spoilage losses due to anerobic respiration have been low in commercial packaging operations because the packaging machine often makes an imperfect heat seal or the film is slightly torn during handling.

Moisture vapor transmission through the package governs the amount of weight loss and wilting of the vegetable. Cellulose acetate and non-moistureproof cellophane allow very rapid loss of moisture. In experiments conducted in the Horticultural laboratories at Gainesville during the past year, the average weight loss of spinach packaged in cellulose acetate was 26% after 8 days at 45° F. During the same time the loss in non-moistureproof cellophane was 37% and in the check package of cheesecloth the weight loss was 40%. The moisture-proof cellophane and Pliofilm packages lost only 2 and 3% in weight. Small holes in the film for ventilation have very little effect on the amount of moisture lost.

Before a film can be used as a packaging material its sealing properties must be known. The Vitafilm, Vinylite, polyethylene, Pliofilm, and heat-sealing cellophane films can be sealed by hand or automatic machines adjusted to the proper temperature for each film. Cellulose acetate and ethyl cellulose films must be sealed with a special glue or solvent. Some prepackers are closing their packages with staples or scotch tape instead of sealing them.

The flexibility of most films is controlled by the amount and type of plasticizer incorporated in the film. Without a plasticizer many plastics are rigid and brittle. Since Pliofilm is made from rubber it is naturally very flexible except at low temperatures, where a softening agent is necessary. Therefore, films are being produced of variable composition for uses at specified temperatures. The tensile strength of any one film varies with the composition and thickness and the temperature at which it is used.

The gauge or thickness of a film has considerable effect upon its physical properties as well as the area of film per pound. Standard types of non-moistureproof cellophane are made in three gauges of .0008, .0012 and .0016 inches in thickness. When these films are moistureproofed approximately .0001 of an inch is added to each film. The area of one pound of .0008 in. plain cellophane is about 23,400 square inches, while the area of the .0009 inch moistureproof film is reduced to approximately 21,000 square inches per pound.

The question of film cost is often raised in connection with prepackaging. The .0009 inch moisture-proof anchor coated cellophane will be used for an example at the January 1, 1947, price of 57c per pound. In overwrapping an average size cardboard tray about 1600 square inches of cellophane will be required. Thus, about 130 packages could be wrapped from one pound of film measuring 21,000 square inches. The cost per package would be approximately .43 of a cent.

Other film manufacturers produce films that are thinner and thicker than those mentioned above. Pliofilm is produced in very thin stretched or tensilized form at 20 guage (.00020 in.). The film with .0016 in. thickness has sufficient rigidity for use in window boxes or bags. Transparent boxes are made from cellulose acetate, Vinylite, and other plastics but the percentage of plasticizer is lowered to produce greater rigidity. A gauge of .010 inch is about the lowest limit of thickness if the box is required to withstand any appreciable pressures. Metal reinforcements are used to join the corners and provide additional support for one type of transparent box.

The prevention of micro-organism growth in consumer packaged vegetables is one of the first essentials in maintaining quality. Rapid changes in taste, color, and texture result from the growth of various types of bacteria and molds. Film manufacturers have produced films with various bactericides and fungicides incorporated in the film. Some of these compounds produce bad odors or tastes and therefore cannot be used. The growth of micro-organisms on the Vinylite film itself is controlled by using tricresyl phosphate instead of the more common plasticizer, dioctyl phthalate.

In our laboratory prepackaging trials this year with green beans and spinach the most outstanding packages were made of Vitafilm with 3 percent tri-o-xenyl borate incorporated in the film. The beans and spinach in this film were still in good condition after 12 days at 42° F.

In conclusion, it should be emphasized that if the packaging of fresh vegetables in consumer sized units is to be a success.

a tremendous amount of research is still necessary on all the phases involved from the time the vegetables are grown in the field until they are eaten by the consumer.

[1]PLATENIUS, HANS, *Modern Packaging*, Vol. 20, No. 2, pp. 139-143, 1946.

[2]SCOTT, L. E., *Pre-Pack-Age*, Vol 1, No. 1, pp. 16-18, 1947.

PREPARATION OF PRODUCE FOR PREPACKAGING

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It is agreed by all that the basic aim of prepackaging is to give the consumer a better product and to procure more favorable economic return for the producer and the retailer.

Under the normal method of handling produce, the inedible portion of vegetables left attached constitutes a large portion of the total shipping weight. Cauliflower represents the extreme case where the curd or edible portion represents only about 40% of the total weight. Fresh corn when husked and trimmed eliminates about 50% of the weight, and even carrot tops account for almost 25% of the normal shipping weight. Aside from the additional transportation costs, there is the added labor cost of removing this inedible portion Accumulation of these waste materials at one location may lead to profitable by-products, such as animal feeds (1, 2).

Handling produce in the same old way up to the retailer or distributor discarding a third or a half in the garbage can, just doesn't make sense.

But let's see how prepackaging might give a better product if given the proper preparation.

Basic quality is the success of any food product, whether fresh, canned or frozen. Basic quality rests on three factors: (1) variety or type of crop, (2) harvesting at the proper stage of maturity, and (3) retention of the desirable constituents during handling, transportation and marketing.

The variety or type of crop must be selected for packaging. Size and shape vary as to variety, and should be chosen for adaptability for prepackaging. Then too, proper production can add in this phase; for example, experiments have revealed that peas can be increased in yield and yet kept in a fancy grade for a longer period by the liberal use of a high nitrogen fertilizer.

Proper maturity is of prime importance, and even though it is already the subject of numerous regulations; nevertheless, it requires considerable attention.

Our third point, retention of the desirable constituents during handling and transportation, is the point which we want to consider in a little more detail.

As we all know, fruits and vegetables are living tissue which respire, and in doing so, the desirable constituents are altered. The higher the temperature, the faster they respire, and the faster they deteriorate.

Leafy vegetables have high heat values, and must be cooled very rapidly to prevent yellowing. The respiration rate of spinach (3) is a good example of the high respiration rate of leafy vegetables.

The principal changes brought about by respiration are: loss of moisture, sugar, Vitamin C, and the loss of other desirable constituents. Asparagus loses almost 6 times as much sugar at 50°F. as at 32°F. Uniced kale (4) loses 44% of its ascorbic acid content in 6 days, 3 times greater than at 32° degrees Fahrenheit. Subsequent changes in the substances in the cell wall leaves produce susceptible to decay producing organisms. All of these contribute to the loss of what we call—freshness.