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# DEHYDROFREEZING OF FRUIT USING DIRECT OSMOSIS AS CONCENTRATION PROCESS

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## INTRODUCTION

Freezing of fruit shows some problems to obtain a high quality standard of the final thawed products. Consumers' trend is to prefer a full-flavored, firm and fresh-like product because the high costs of the freezing of fresh fruit (water content 85-90%) and the poor quality at thawing, sometimes the freezing process becomes not convenient [1].

The quality changes owing to freezing can be brought to the follows:

— texture degradations by growing up of the ice crystals and thawing collapse;

— alterations of taste owing to concentration of organic acids and juice dripping during thawing;

— changes of colour by enzymatic activities (mainly browning) induced by freezing, and accelerated during thawing.

Partial water removal (up to 50%) of the fruit prior freezing process leads to the concentration of the cytoplasmatic components within cells, the reduction of free water content, the depression of the freezing point, the increase of the degree of undercooling [2].

All this permits [3].

— reduction of total latent heat of freezing;

— less energetic demand into the freezing process,

— higher freezing rate;

— increase of phenomenon of microcrystallization owing to the lower solids/crystals ratio;

— weight and volume reduction of frozen fruit to 50% or less;

— better texture and taste when the fruit is thawed;

— less drip loss at thawing.

The traditional dehydrofreezing process includes an evaporative step and in most cases it is necessary a pretreatment to prevent enzyme oxidations occurring during the evaporation process. Fruit such as apples, peaches, apricots or cherries must be treated with heat (blanching) or dipped into a sulfite solution to inactivate enzymes [4, 5].

Substituting the evaporative step in the usual dehydrofreezing with an osmotic concentration it is possible to achieve some others benefits [6].

Osmotic process is a water removel process which is based on placing foods, such as pieces of fruit, in a hypertonic solution (as a concentrated sugar solution). This dehydration process is characterized mainly by the following aspects [7, 8]:

— uptake of solids from the osmotic solution;
— increase in sugar content of fruit;
— partial protection from enzyme activity;
— low energetic demand for water removal;
— improvement in flavour, taste and color of the final product.

The osmotic concentration can be combined with the preparative steps prior freezing; thus we can call this process Osmo-Dehydro-Freezing.

In this work the effects of the osmotic concentration on different kind of fruit prior freezing (osmo-dehydro-freezing) were evaluated, taking into account some properties and the quality of the product before freezing and at thawing, in comparison with the sample undertook to standard freezing.

## MATERIALS AND METHODS

Strawberries, raspberries, apricots and cherries were purchased from a local food supplier. The fruit was manually peeled, pitted and halved then undertook to osmotic treatment in H.F.C.S. (High Fructose Corn Syrup) added with 1% of NaCl. The treatment was carried out at ambinet temperature, with movement of the syrup, as long as 8 and 16 hours.

On the osmodehydrated products the following analysis has been leaded:

— weight reduction %;
— water lost % of initial water;
— solid gain g/100 g of fresh fruit;
— firmness (g) by means a penetrometer (ø 3 mm);
— panel test undertaking the products to at least 10 unexpert judges.

After treated the fruit were dripped for 5 minutes on an iron net to drain the excess of syrup, the frozen in an air-blast discontinuous freezer set up at-40°C measuring the freezing rate and the freezing point. The frozen products were stored at-20°C.

Thawing was carried out at ambient conditions, evaluating firmness, loat of drip % by weight and the thawing rate. Characteristics of fresh frozen-thawed fruits in comparison with osmo-dehydro-frozen thawed products were evaluated by means a panel test keeping into account flavour, colour and texture and throughout GLC analysis of the volatiles into the head space.

## RESULTS

During the osmotic treatment the fruit was able to loss up to 70% of the initial water content (Fig. 1), reducing from 30% to 50% the weight of the fresh fruit. In addition there is another interesting phenomenon: the gain of solutes (mainly mono, di and polysaccharides) increases the solid content and improves the taste of the fruit that goes to the freezing with a lower free water content, but normally with a lower consistency in comparison with the fresh.

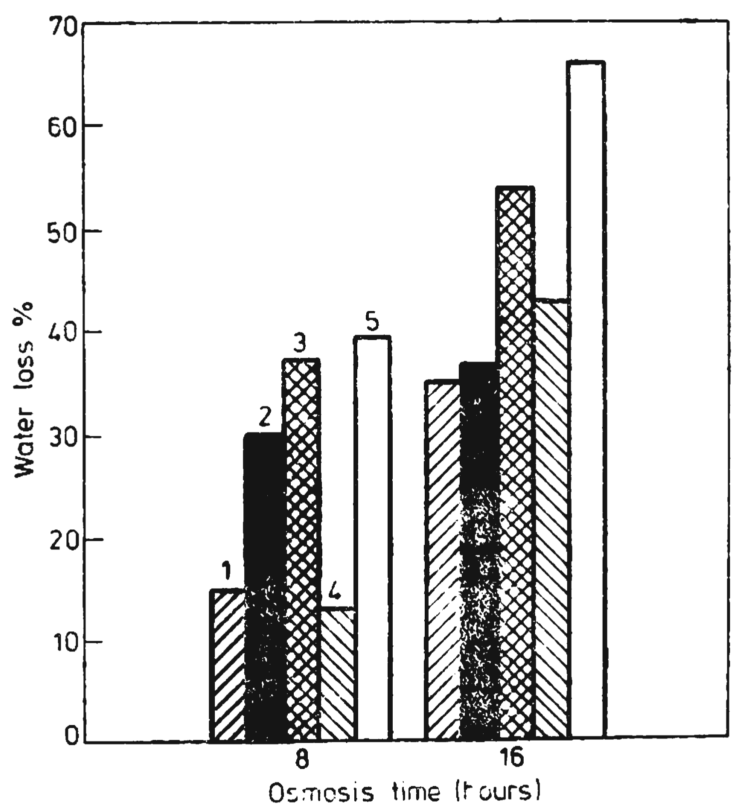


Fig. 1. Bars graph showing the values of water lost % in fruits undertook to osmotic treatment at different time; 1 — raspberries, 2 — halwed apricots, 3 — pitted cherries, 4 — strawberries (whole), 5 — strawberries (pieces)

Because of its less water content the osmosed fruit shows a higher freezing rate, and an evident depression of the freezing point (almost 3°C) (Fig. 2).

At frozen state, the fresh fruit has a very hard texture while the osmo-dehydrofrozen one shows a pleasant, well-firm texture. So it is possible its successful use into a ice-cream formulation.

At thawing, the osmodehyrofrozen fruit shows a strong reduction of the thawing time, a minimal drip loss (Fig. 3) and some time a better firmness that the fresh frozen product (Fig. 4).

The product's quality evaluated by sensory analysis and by means the GLC analysis of the head space in equilibrium with the samples has shown as in every

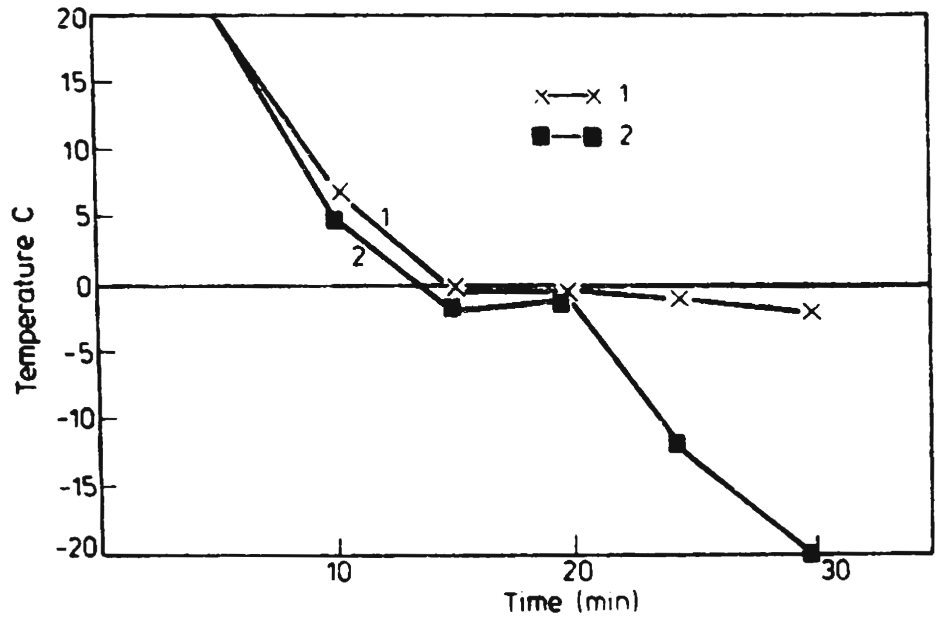


Fig. 2. Curves of descrease of temperature as a function of the freezing time for untreated and osmotically treated strawberries; 1—fresh, 2—osmosed (8 hrs)

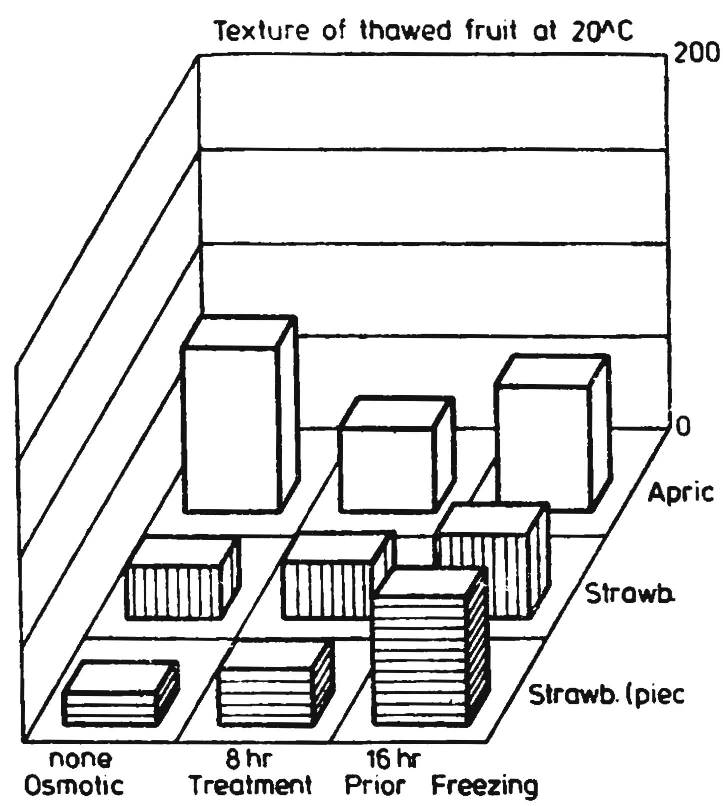


Fig. 3. Behaviour at thawing, evaluated as drip loss %, of untreated and osmo-treated different frozen fruits

case the osmodehydrofrozen fruit gains a higher panel's score as better taste, flavour, colour and shows more richness or aromatic volatiles (Fig. 5).

The low energetic demand during concentration (theoretically = zero; no changes of phase occurs) with the same benefits of the dehydrofreezing (less water to freeze, less volume and weight of the product to storage and to transport) make the osmo-dehydro-freezing an interesting process to reduce the energy consumption during the freezing of fruit (Fig. 6).

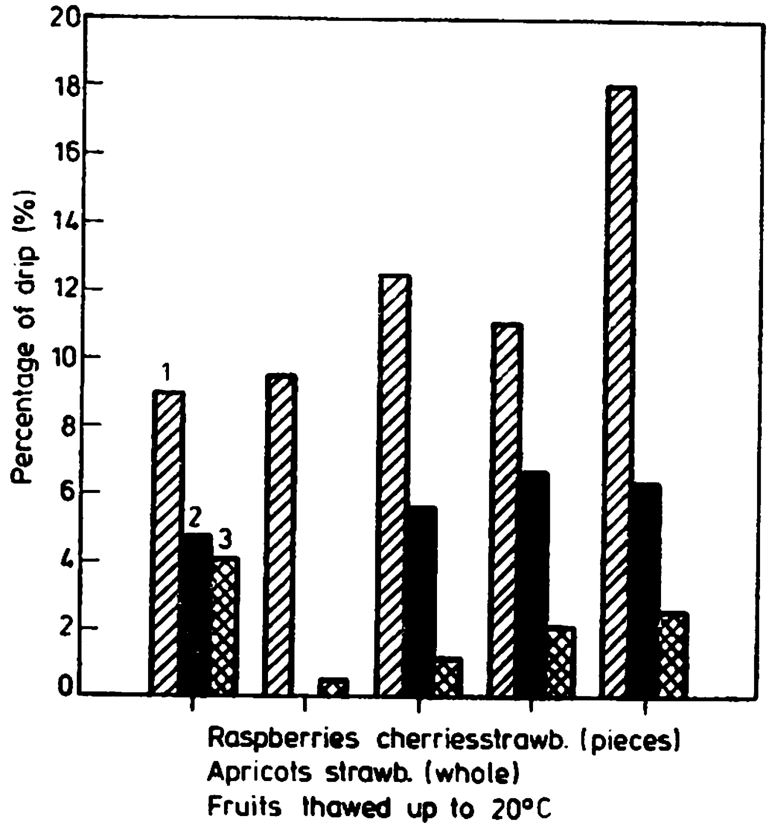


Fig. 4. Values of firmness (by penetrometric measurements; average on 4 samples) after thawing up to 20°C shown by some kind of fruit, untreated and osmotically treated prior to freezing; treatment prior freezing; 1 — none (fresh), 2 — osmosis 8 hr, 3 — osmosis 16 hr

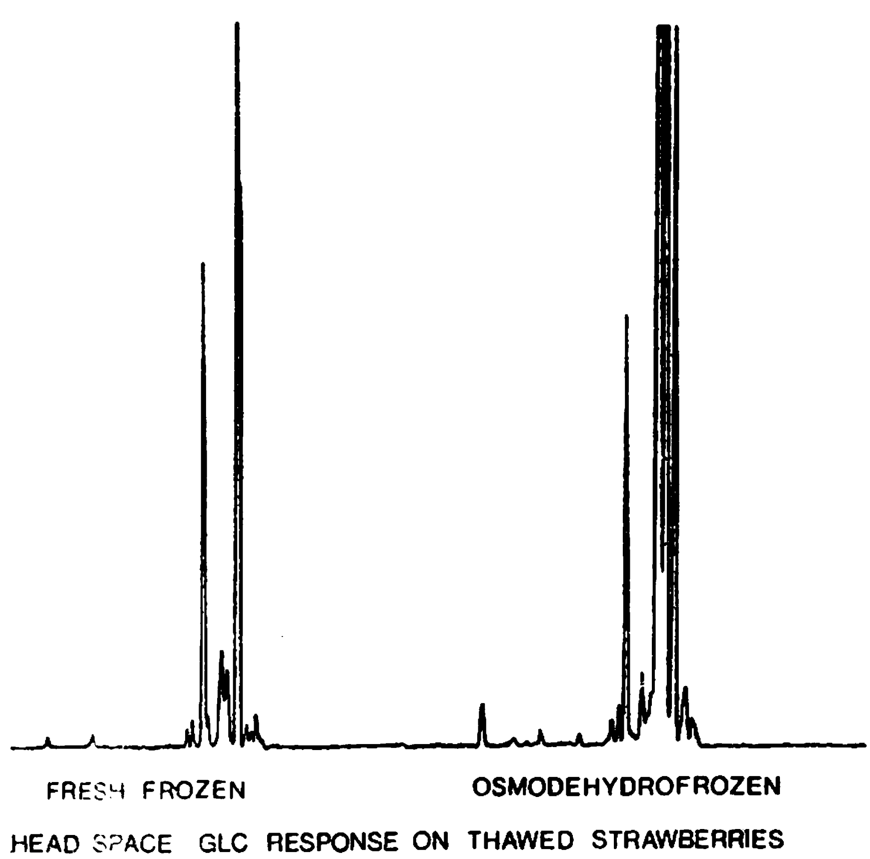


Fig. 5. GLC profiles of head space analysis of fresh and osmo-treated strawberries after thawing. Gaschromatograph apparatus was a Carlo Erba HRGLC equipped with a FID detector using a 40 m glass capillary column coated by FFAP. Column temperature 110°C, detector and injector 210°C, carrier gas Helium at 2.3 ml/min, split ratio 1:80

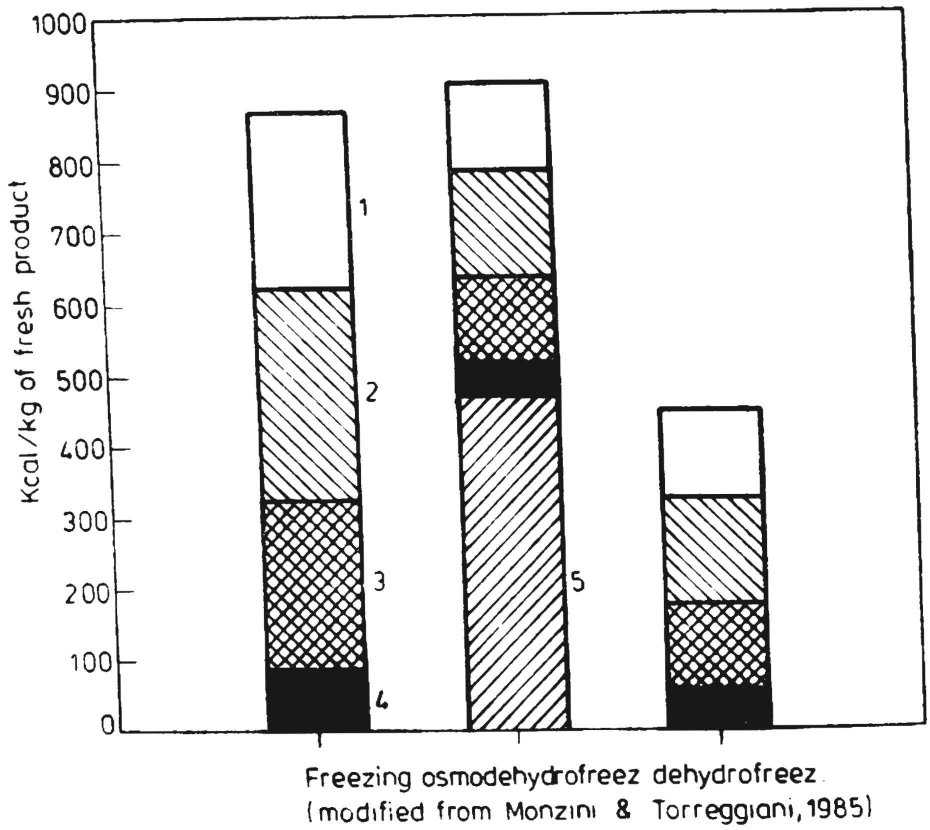


Fig. 6. Energy involved in three different freezing processes taking into account the demand (estimated in kcal/kg of fresh product) for every process' step; 1 — storage, 2 — transport, 3 — packaging, 4 — freezing, 5 — drying

## CONCLUSION

Because of the lower energetic demand during process, better texture, better teste, colour and aroma in comparison with the respective fresh-frozen samples, the osmodehydrofreezing shows a very interesting alternative to the traditional fruit processes.

In respect to dehydrofreezing, the osmodehydrofreezing leads some advantages such as a more convenient energetic balance in the water removal and the possibility to reduce or to eliminate the use of $SO_2$.

On this purpose, the use of an osmotic concentration step at high temperature for few minutes would achieve to avoid any sulfite treatment, combining a fast concentration to an enzyme inactivation (blanching).

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ZAMRAŻANIE OWOCÓW CZĘŚCIOWO ODWODNIONYCH PRZEZ BEZPOŚREDNIĄ OSMOZĘ

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Streszczenie

Proces zamrażania w stanie częściowego odwodnienia (ang. dehydrofreezing) obejmuje częściowe osuszenie produktu przed mrożeniem. Niższa zawartość wody w produkcie podczas mrożenia daje następujące korzyści:

— niższe zużycie energii na jednostkę świeżego produktu w czasie etapu mrożenia i późniejszego składowania,

— obniżenie punktu krioskopowego, zmniejszenie ilości wody wymrażanej i wzrost szybkości mrożenia i rozmrażania.

Bezpośrednia osmoza była przebadana jako technika odwodnieniowa dla wielu rodzajów owoców. Uzyskano ponadto następujące korzyści:

— obniżenie zapotrzebowania na energię w procesie suszenia,

— wzrost ogólnej zawartości składników suchej masy w produkcie z utrzymaniem konsystencji,

— pobranie cukrów z syropu, lepsze zachowanie aromatu i lepsze zachowanie barwy,

— obniżenie kwasowości i polepszenie właściwości organoleptycznych,

— obniżenie skłonności do enzymatycznego brunatnienia.