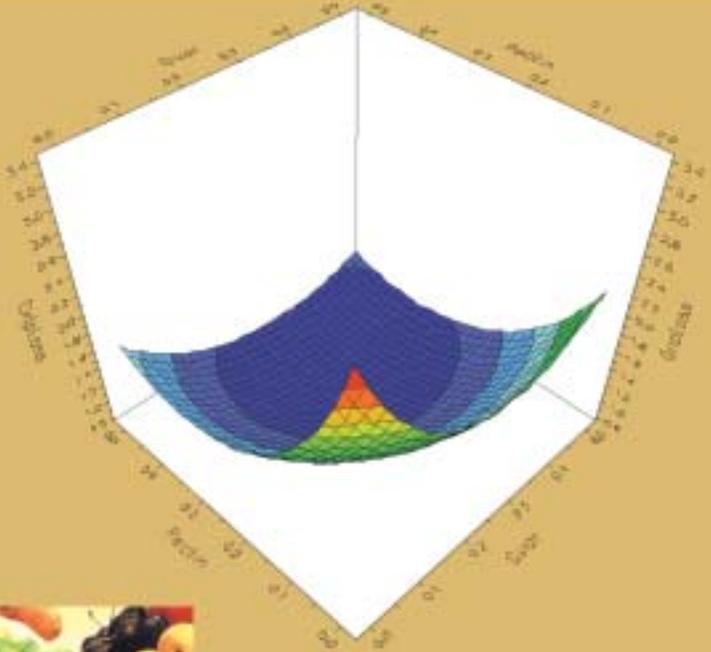


# Texture of Fruit and Vegetable Components of Ready Meals



**The National  
Food Centre**

RESEARCH & TRAINING FOR THE FOOD INDUSTRY

RESEARCH REPORT NO 27



## TEXTURE OF FRUIT AND VEGETABLE

## COMPONENTS OF READY MEALS

### Author:

---

Gerard Downey B.Sc. Ph.D. MIFSTI  
The National Food Centre  
Teagasc, Dunsinea, Castleknock, Dublin 15

ISBN 1-84170-156-4  
December 2000



AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY





## CONTENTS

<b>Summary</b>	<b>1</b>
<b>Introduction</b>	<b>1</b>
<b>Single cryoprotectant incorporation in vegetables</b>	<b>3</b>
Experimental procedures	3
Addition of hydrocolloids, gums, dairy powders and lupin albumin to vegetable purées	4
Potato purée	4
Carrot purée	6
Turnip purée	8
Potato and oil applications	10
Addition of soluble & insoluble rape albumin to vegetable purées	11
<b>Cryoprotectant mixtures</b>	<b>12</b>
Potato, carrot & turnip studies	12
Studies with ingredient mixture 1 (guar, whey protein & pectin)	13
Studies with ingredient mixture 2 (xanthan, caseinate and carrageenan)	17
Potato studies with lupin albumin	18
<b>Cryoprotectant studies – apple</b>	<b>19</b>
Studies with apple purée	19
Studies with apple purée and lupin protein extracts	19



Conclusions 21

---

Recommendations to industry 21

---

Acknowledgements 22

---

Appendix 1. Experimental methods 22

---



## SUMMARY

Vegetable and fruit purées are important parts of prepared ready-meals. Further expansion of this food sector will depend among other things on improved and consistent product quality. Innovative organoleptic properties in ready-meal components will assist in product diversification and the growth of market share.

Limiting the organoleptic deterioration which arises from freezing and thawing is one strategy for quality improvement. In this report, the results of a study into the effect of incorporating cryoprotectants into representative purées are presented. These cryoprotectants were xanthan gum, guar gum, carrageenan, pectin, sodium caseinate, whey protein concentrate and protein extracts from lupin and rapeseed. The quality parameters studied were maximum resistance (vegetables) or maximum viscosity (fruit), drip loss and colour (Hunter  $L$ ,  $a$  and  $b$  values).

The results show that:

- (a) it is possible to significantly modify purée quality by incorporation of cryoprotectants;
- (b) the effect achieved depends on the cryoprotectant used;
- (c) novel proteins extracted from lupin and rape seeds did not demonstrate any significant cryoprotectant properties in this work;
- (d) using mixtures, it is possible to tailor purées with a desired range of organoleptic properties.

## INTRODUCTION

The consumer is the primary driver of many of the changes in the way food products are manufactured and marketed. Consumers today are concerned with healthy eating and convenience and have a critical attitude towards price and value. Changing lifestyles will continue to support greater demand for convenience foods, a market sector which has demonstrated 33% growth between 1997 and 1999 in Ireland.



Of key importance to the continued development of this sector is an emphasis on quality as well as value for money. This requires that constant attention be paid to the organoleptic properties of ready-meals, most of which are purchased by the consumer in the frozen state. Freezing and thawing of foods can have a detrimental effect on their sensory and water-holding properties as a result of changes to the structure of macromolecules. Undesirable changes normally resulting include increased drip and loss of texture. Technological solutions adopted by industry to minimise the effects of freezing include the use of rapid blast freezing methods. While these are effective, the thawing process remains potentially damaging. One possible strategy to minimise damage from this step is to incorporate compounds into the food which interact with water and offer protection against the deleterious effects of thawing *i.e.* cryoprotectants.

Hydrocolloids (carrageenan and pectin), gums (xanthan and guar) and dairy proteins (sodium caseinate and whey protein concentrate) possess cryoprotectant properties. The effectiveness of some such molecules has been studied in fish and dairy products. However, the effect of their inclusion on the freeze-thaw properties of vegetables (including potatoes) and fruit is less well known.

Certain plant proteins possess cryoprotective properties but little is known about the effects, if any, of protein extracts from rapeseed and lupin, two commercial crops which grow well in Ireland. Should such protein extracts possess cryoprotective properties, their industrial extraction would represent a valuable ingredient resource for the local food industry and an extra outlet for the agricultural commodity.

Mixtures of cryoprotectants may offer specific advantages with regard to alterations in the organoleptic properties of processed food. The traditional approach to the study of mixtures is to keep the concentration of one ingredient constant and vary the level of another until a maximum or minimum in some important quality parameter is reached. However, this strategy is not guaranteed to arrive at the optimum solution. Techniques to overcome this shortcoming require complex statistical designs to ensure the efficient extraction of information. Commercial software to facilitate this process is now available.



This project therefore aimed to offer improved frozen-then-thawed ready-meal components by providing answers to the following questions:

- what are the effects of including cryoprotectant compounds on the organoleptic properties of representative vegetables and fruit?
- what are the corresponding effects of incorporating novel proteins extracted from rapeseed and lupin?
- how can the organoleptic changes be optimised through the use of mixtures of existing or novel cryoprotectants?

## SINGLE CRYOPROTECTANT INCORPORATION IN VEGETABLES

### Experimental procedures

Range finding experiments were performed in order to ascertain the maximum amount of each cryoprotectant which could be added to each of the meal components studied. Since any foodstuff produced had to be suitable for consumption, this assessment was made by experienced testers on the basis of viscosity and flavour, although colour did play a lesser role. On this somewhat empirical basis, the following levels of cryoprotectant use were established:

Carrageenan:	0.5g per 100g	Pectin:	0.5g per 100g
Xanthan:	0.1g per 100g	Guar:	0.1g per 100g
Whey protein concentrate:	4g per 100g	Sodium caseinate:	1g per 100g
Lupin albumin	0.5g per 100g		

In single cryoprotectant studies, the above were the concentrations of each cryoprotectant utilised. In the designed experiments, these values were used as the maximum incorporation rates. General experimental methods followed in this work are outlined in the Appendix.



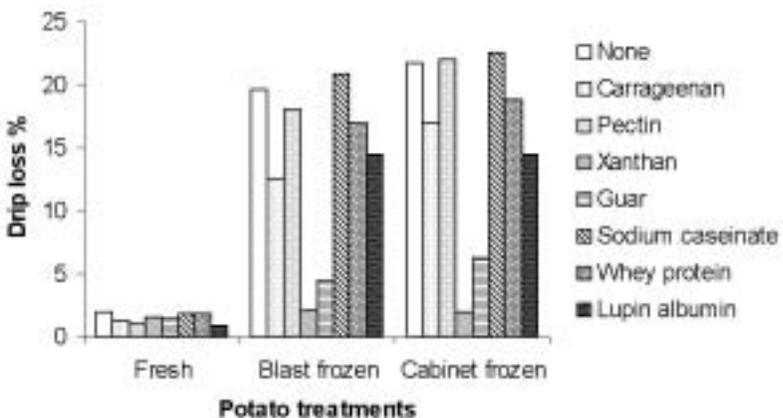
## Addition of hydrocolloids, gums, dairy powders & lupin albumin to vegetable purées

---

### *Potato purée*

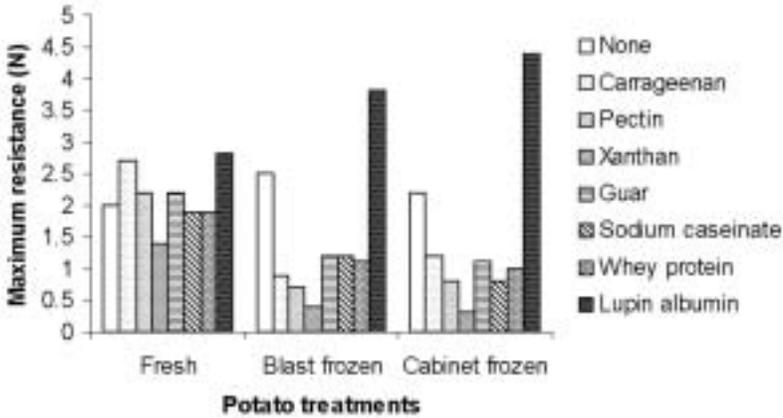
The effects of each cryoprotectant on drip loss and maximum resistance of potato purées are shown in Figures 1 and 2 respectively. A number of points emerge from these figures. In relation to drip loss, it is apparent that:

- (a) all of the additives decreased the measured drip loss in fresh potato purée although for most this effect was not significant;
- (b) major increases in drip loss occurred after both freezing treatments; blast freezing was almost as severe as cabinet freezing;
- (c) neither dairy ingredients nor pectin significantly diminished drip loss after either freezing process;
- (d) xanthan and guar markedly reduced drip loss, xanthan being the more effective;
- (e) carrageenan and lupin albumin produced slight and comparable drip loss reductions.



**Figure 1:** Effect of cryoprotectants and freezing treatments on drip loss of potato purées.

---



**Figure 2:** Effect of cryoprotectants and freezing treatments on maximum resistance in potato purées.

Examination of Figure 2 reveals the following;

- (a) maximum resistance recorded for potato purée alone exhibited an increase after both freezing treatments with blast freezing producing the greater rise;
- (b) the addition of carrageenan to fresh potato increased maximum resistance values;
- (c) all of the conventional ingredients tested reduced the maximum resistance after freezing by either method;
- (d) whey protein concentrate, sodium caseinate and guar produced effects of similar magnitude;
- (e) xanthan produced the greatest reduction in maximum resistance after freezing and thawing;
- (f) the novel ingredient lupin albumin increased maximum resistance values after either freezing treatment but especially after cabinet freezing.

Thus, in order to reduce drip loss and maximum resistance values in potato purées after freezing and thawing, either xanthan or guar gums are the best of the cryoprotectants



Given that the maximum acceptable levels of cryoprotectants were used, it should be possible to adjust the actual effects of their incorporation by altering their usage levels.

With regard to purée colour, none of the treatments or added cryoprotectants had any effect of practical significance on Hunter  $L$ ,  $a$  or  $b$  values.

Sensory panels ranked the frozen then thawed potato purées on the basis of their overall acceptability. Only blast frozen material and its fresh counterpart were tested and because of the limited number of samples which it is possible to compare at one time, experiments were conducted on two separate occasions. In summary, however, it is possible to state that:

- (a) in general, non-frozen samples were preferred to the frozen then thawed;
- (b) pectin addition was not adversely received by the panellists;
- (c) guar and xanthan gums were the least preferred of the additions tested.

It is important to note that sensory testing of purées containing novel protein extracts could be not performed since they were not prepared under conditions appropriate for food grade materials.

#### *Carrot purée*

The effects of cryoprotectants in carrot purées are shown in Figures 3 & 4. As a general observation, carrot preparations were much more variable in drip loss and maximum resistance than was the case for potatoes. Against this background, the following observations may be made:

- (a) drip losses in fresh carrot purées were much higher than in the case of potatoes;
- (b) drip losses were increased slightly after freezing by either method; no significant differences were detected between blast or cabinet freezing;
- (c) dairy powders offered no significant reduction in drip loss in either the fresh or thawed state;
- (d) guar, xanthan, carrageenan and pectin significantly reduced drip losses in fresh and thawed carrot purées; pectin was the least effective of these four;

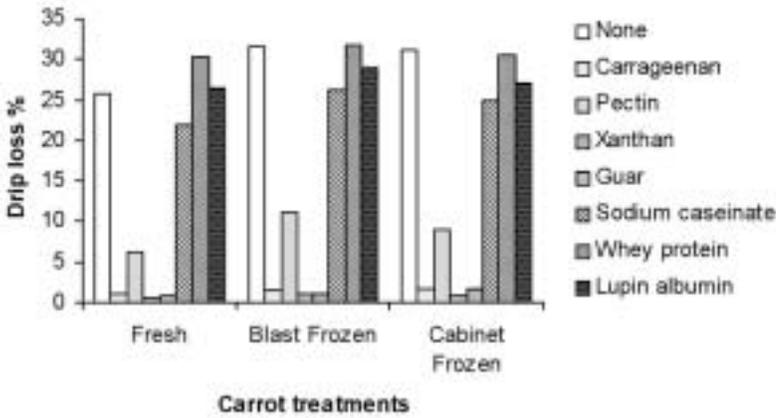


Figure 3: Effect of cryoprotectants and freezing treatments on drip loss in carrot purées.

(e) lupin albumin showed no significant effect on drip loss values either before or after freezing.

With regard to maximum resistance measurements (Figure 4),

(a) all cryoprotectants significantly reduced the resistance value of fresh carrot purée;

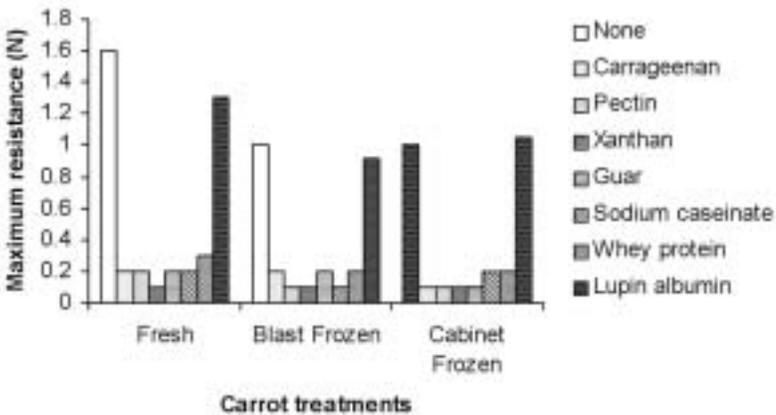


Figure 4: Effect of cryoprotectants and freezing treatments on maximum resistance in carrot purées.



- (b) freezing and thawing reduced the resistance value of carrot purée;
- (c) lupin albumin did not exert any significant effect on maximum resistance values in either the fresh or thawed state;
- (d) all of the conventional cryoprotectants caused an unacceptable reduction in resistance in both fresh and thawed carrot purées.

Sensory analysis of these carrot purées revealed that:

- (a) fresh produce was preferred over thawed samples;
- (b) carrot purées without any additions were preferred over those with cryoprotectants;
- (c) frozen and thawed purées containing cryoprotectants were preferred over the same combinations in the fresh state.

As in the case of potato purées, these general trends were obvious although statistically significant differences were not always found. No effect on colour of any practical significance resulted from the incorporation of any cryoprotectant to carrot purée.

#### *Turnip purée*

The results of cryoprotectant addition to turnip purée are shown in Figures 5 & 6. These may be summarised as follows:

- a) drip loss behaviour was very similar to that of carrots *i.e.* it increased on freezing and thawing;
- (b) neither lupin albumin nor dairy powder had any significant effect on drip loss values;
- (c) guar, xanthan, carrageenan and pectin significantly reduced drip losses in turnip purées before and after thawing - pectin was the least effective of these;
- (d) maximum resistance behaviour (Figure 6) resembled potato more than carrot;

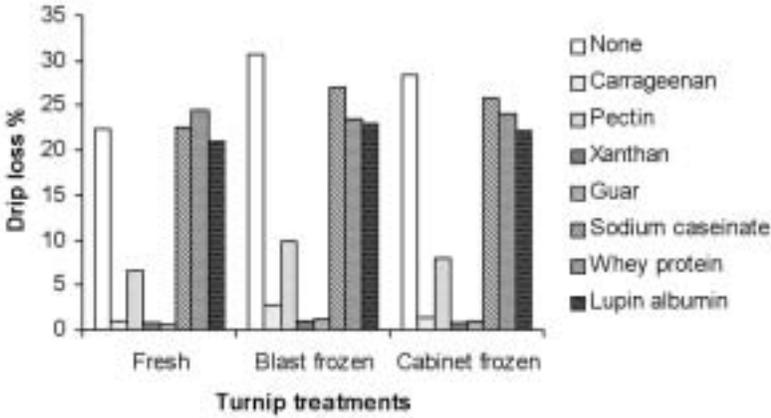


Figure 5: Effect of cryoprotectants and freezing treatments on drip loss in turnip purées

- (e) only sodium caseinate, xanthan and carrageenan produced significant maximum resistance reductions in the fresh and frozen then thawed purée;
- (f) lupin albumin did not affect resistance value in the fresh purée but increased it after freezing and thawing.

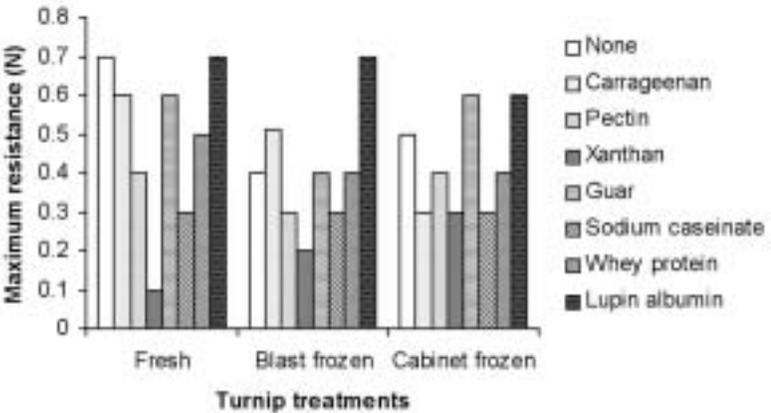


Figure 6: Effect of cryoprotectants and freezing treatments on maximum resistance in turnip purées



Sensory analysis of the turnip purées revealed results very similar to those of the carrot purées i.e. general preference for purées without additions and, when these are present, preference for the frozen material over the fresh. Similarly, no significant effect on turnip purée colour arose from the incorporation of any cryoprotectant.

In summary, the effect on drip loss and maximum resistance of cryoprotectant addition varies from vegetable to vegetable and with usage rate. Reductions in drip loss are always desirable. The quality implications of changes in resistance will vary depending on product but options to variously control this parameter do exist.

### *Potato and oil applications*

Mashed potato may be produced with oil or butter to mimic domestic usage and improve mouthfeel. For this reason, the effect of incorporating a selected hydrocolloid (carrageenan, 0.5g per 100g purée) into such a product was studied.

Potato was mashed with the addition of vegetable oil (Crest Foods Ltd, Dublin) at 5, 10 and 15g per 100g purée levels. These levels are somewhat arbitrary and were selected on a trial basis although the 15% inclusion rate represents an organoleptic maximum on the basis of subjective assessment of appearance by laboratory staff. In addition to resistance and drip tests, measurements on the absorption of oil by the potato purées were also made. The addition of oil to mashed potatoes resulted in a decrease in Hunter *L* & *b* values and an increase in *a* values i.e. they became less white. As may be expected, the presence of oil significantly reduced maximum resistance; carrageenan made this reduction bigger, especially after freezing and thawing. No difference in maximum resistance loss was found between the two freezing methods. The inclusion of oil did not significantly affect the drip loss of fresh samples. Freezing and thawing increased drip loss, more so for cabinet frozen potato than for the blast-frozen material. The presence of oil reduced the size of this increase. Carrageenan effected a further reduction. Thus we can report an additive effect of carrageenan and oil in reducing drip loss and maximum resistance after thawing. This information will be of assistance in designing potato purée with good consistency and low drip.



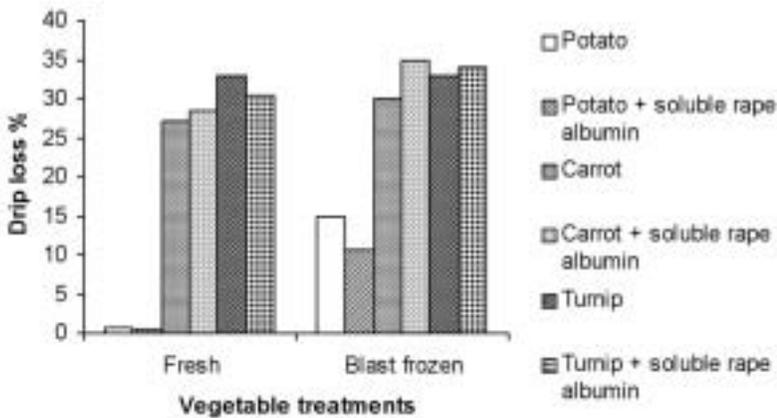
As oil content increased, the amount of oil absorbed by potatoes and not removed by centrifugation increased linearly. Inclusion of carrageenan reduced this absorption in both the fresh and thawed samples. This observation may have implications for the mouthfeel of oil-containing purées.

### Addition of soluble and insoluble rape albumin to vegetable purées.

---

A small quantity of both soluble and insoluble rape albumin was prepared at the University of Limerick. Because of the limited amount of material involved, only fresh and blast frozen purées were studied on the basis that the latter is the more common industrial freezing technology. It was not possible to replicate the experiments with several different lots of vegetables as is normal practice; thus, results obtained may only be used to establish trends rather than specific values for texture and drip.

Soluble rape albumin had no practical effect on maximum resistance of potato, carrot or turnip purées in the fresh state. After blast freezing and thawing, a reduction in resistance value was obtained in the case of potato but not for carrot or turnip. Similar behaviour was noted in the case of drip loss (Figure 7). Soluble rape albumin had no practical effect on the colour of these



**Figure 7:** Effect of the addition of soluble albumin extract from rapeseed on drip loss of vegetable purées.

---



purées. Thus, this soluble protein extract had no functional effect on the properties of carrot or turnip purées while a small positive effect was noticed in the case of potatoes.

Insoluble rape albumin behaved similarly to the soluble extract. Thus, no significant effect was noticed with carrots or turnips; in the case of potatoes, a reduction of maximum resistance value was observed as was a reduction (by approximately 10%) of the drip loss after freezing and thawing. No practical effect on colour was found for any of the three purées.

In summary, while effects on the properties of mashed potatoes were identified, neither soluble nor insoluble albumin from oil seed rape was found to possess unique functional properties when added to these ready-meal vegetable components.

## CRYOPROTECTANT MIXTURES

The aim was to characterise the response of potato, carrot and vegetable purées to the structured inclusion of ingredient mixtures. The initial work incorporated hydrocolloids, dairy powders and gums in all three purées while a subsequent study included lupin albumin but only for potato mash.

### Potato, carrot and turnip studies

Six ingredients were used: two hydrocolloids (carrageenan & pectin), two gums (xanthan & guar) and two dairy powders (whey protein concentrate & sodium caseinate). To make the ingredient systems easy to model and to reflect likely commercial usage, the ingredient set was split into two. Another consideration was to include one ingredient of each type in a set of experiments given that it would be unusual to include two ingredients of the same type (e.g. carrageenan & pectin or whey protein concentrate & sodium caseinate) in one product. Two experimental designs were therefore set up: set 1 (containing guar, pectin and whey protein concentrate) and set 2 (containing xanthan, sodium caseinate and carrageenan).

The conventional way to investigate such mixtures is to keep a single ingredient at a constant level and vary the others in a systematic way. This approach requires a large number of experiments, is costly and time-



consuming. More worryingly, there is no way of being certain that the optimum effect for any combination is achieved *e.g.* there is no way of knowing that the minimum resistance value observed for a particular combination of ingredients is the minimum actually achievable. In order to overcome the issues of cost and uncertainty a statistical approach called experimental design is preferred and this was used in the mixture studies described below.

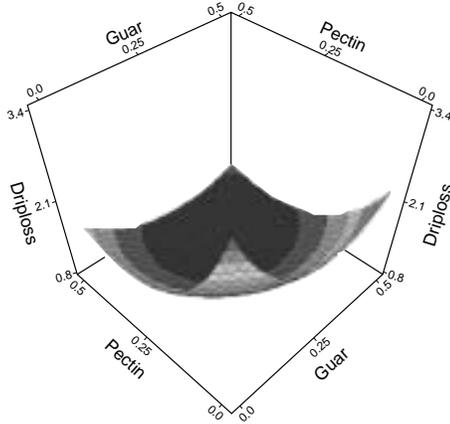
*Studies with ingredient mixture 1 (guar, whey protein concentrate & pectin)*

For a three ingredient mixture such as this, a total of 17 individual experiments were developed to model all possible ingredient combinations. Quantities of ingredients added were indicated by the software package used in this work (MODDE 5, Umetrics AB, Umeå, Sweden) on the basis of statistical theory.

The statistical software analysed the measured responses (maximum resistance value, drip loss, colour) to these additions and predicted the response for all possible combinations of the three ingredients involved. In this way, a “response surface” was generated allowing the exact ingredient mixture to be calculated for any particular value of drip loss or maximum resistance. Drip loss and maximum resistance of mashed potato were modelled with reasonable success. The response surfaces calculated are shown in Figures 8 and 9.

Figure 8 predicts a minimum value for drip loss for a range of pectin and guar inclusion levels. To draw this graph, the level of whey protein concentrate was set at its maximum level of 4%; similar graphs are obtained for lower values of whey protein concentrate inclusion but the minimum resistance point becomes less well-defined. However, it is clear that the achievement of any target drip loss value is achievable for a range of ingredient levels. This is an important outcome because it may be desirable to limit the inclusion of one or more ingredients for reasons such as cost, effect on colour or flavour etc.

The outcome of resistance modelling was less successful due to the complex interaction between the constituents of this system. With whey protein concentrate held at an inclusion rate of 2g per 100g purée, the response surface obtained was complex. No overall minimum was obvious although

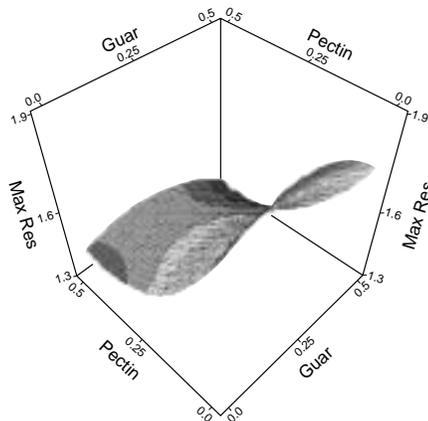


**Figure 8:** Response surface for drip loss in mashed potato incorporating a 3-ingredient cryoprotectant mixture.

---

minima were obtained at two corners of the surface shown in Figure 9. Here again a range of ingredient usage rates may be selected to achieve a particular maximum resistance value.

Similar experiments were designed and analysed for turnip and carrot purées. It was possible to model drip loss of turnip with reasonable accuracy but this



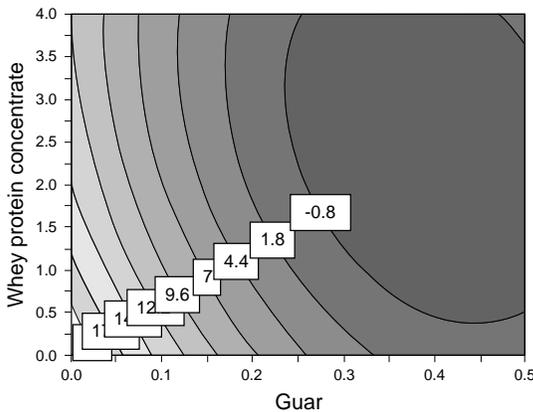
**Figure 9:** Response surface for maximum resistance in mashed potato incorporating a 3-ingredient cryoprotectant mixture.

---

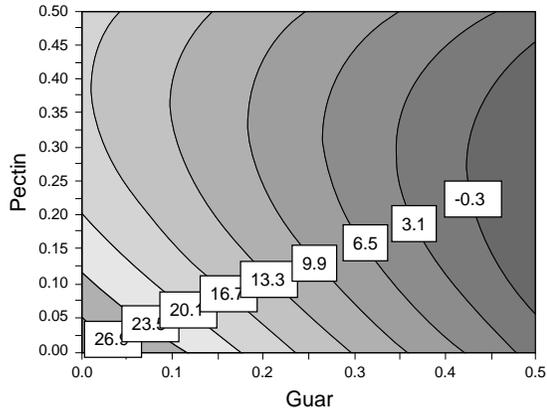


was not the case for maximum resistance. Both of these responses were correlated to the inclusion level of guar in particular and to whey protein concentrate to a lesser degree. Pectin content was shown not to be highly correlated to either drip or resistance. In this case, a 2-dimensional response surface is the clearest graphical display of the predictive models and one for drip loss is shown in Figure 10. Here also, it was possible to tailor drip loss by careful selection of the inclusion levels of the three ingredients. Data shown in boxes in Figure 10 are actual drip loss values associated with each band on the plane. Some inaccuracy in the model is revealed by a negative value at high inclusion levels of guar.

The study of carrot purée revealed that guar was the major influence on drip loss and modelling of this response was moderately successful. Unlike turnip, whey protein concentrate had less of an effect than pectin and a 2-dimensional plane revealed the outcome. For any given level of guar inclusion, increasing the quantity of pectin initially reduced drip loss but on reaching values of approximately 0.25% pectin, this behaviour was reversed (Figure 11). Therefore, for any desired level of drip loss within the limits plotted, a range of guar:pectin ratios exist. This plot has no maximum or minimum. This is because any such minimum exists at levels of ingredient inclusion which are



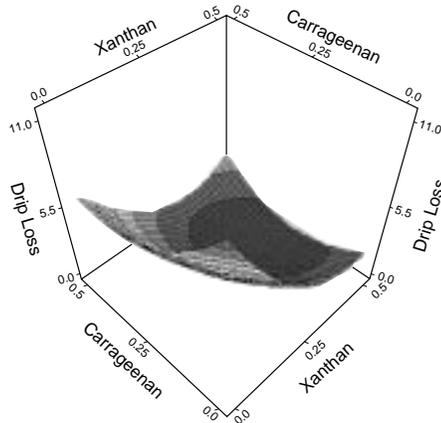
**Figure 10:** A 2-dimensional response surface model of drip loss in turnip purée containing 0.5g of pectin per 100g of purée and varying amounts of whey protein concentrate and guar. Values in boxes are percentage drip loss figures.



**Figure 11:** A 2-dimensional response surface for drip loss in carrot purée containing 2g of whey protein concentrate per 100g of purée and varying amounts of pectin and guar. Values in boxes are drip losses.

---

outside the self-imposed limits used in the experimental design. However, the trend in the response variable is clear from the graph and the experimental range could be extended should this be important.



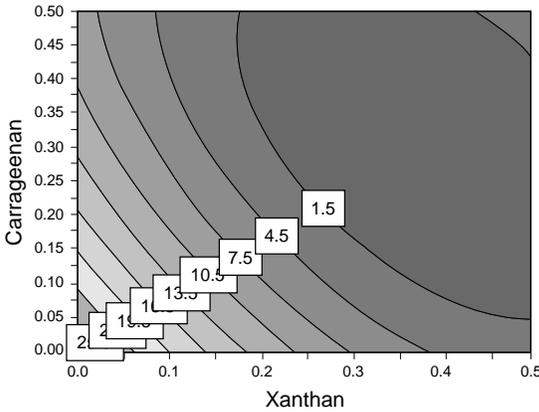
**Figure 12:** Response surface for drip loss prediction in potato purée incorporating a 3-ingredient cryoprotectant mixture (xanthan, carrageenan and sodium caseinate)

---

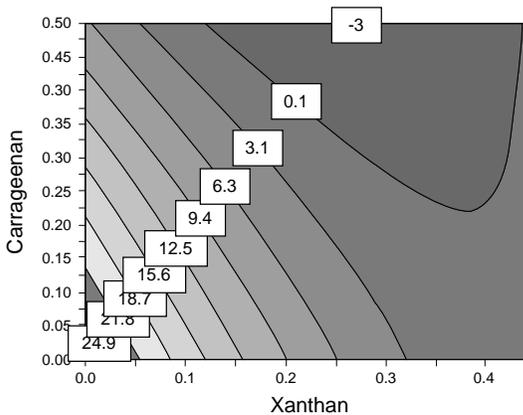


*Studies with ingredient mixture 2 (xanthan, sodium caseinate & carrageenan)*

Results from these experiments are shown graphically in Figures 12, 13 & 14. The main outcome was that xanthan emerged as the most significant ingredient in the control of drip loss and maximum resistance. Drip loss was



**Figure 13:** A 2-dimensional response surface for drip loss prediction in turnip purée containing 0.5g sodium caseinate per 100g turnip and varying amounts of xanthan and carrageenan. Values shown in boxes are drip losses.



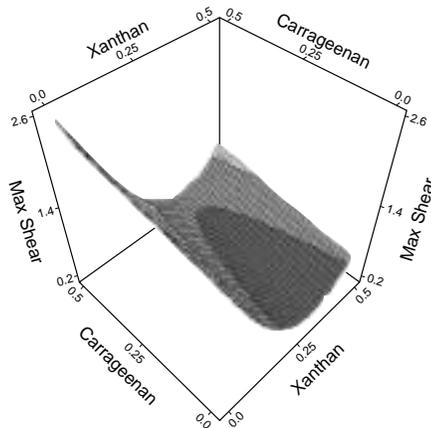
**Figure 14:** A 2-dimensional response surface for drip loss prediction in carrot purée containing 0.5g sodium caseinate per 100g carrot and varying amounts of xanthan and carrageenan. Values shown in boxes are drip losses.



well modelled for potato and turnip but not maximum resistance. For carrots, neither parameter was modelled successfully. These results are analogous with those obtained using ingredient mixture 1 reported above. Thus, for drip loss, minima were achieved for potato and turnip while a more complex response surface was obtained for carrot. Maximum resistance was not successfully modelled by ingredient mixture 2 due to the lack of significant variation in resistance in any of the designed experiments.

### *Potato studies with lupin albumin*

On the basis of experience gained in earlier work, this investigation was executed in two sets of experiments. Set A used xanthan, carrageenan, casein and lupin while Set B included guar, pectin, whey protein concentrate and lupin albumin. In both sets, lupin albumin was found to be significantly correlated with purée colour (Hunter *a* and *b* values). However, casein (Set A) was found not to play an important role in either maximum resistance or drip loss regulation; in its absence, lupin did play a small but interesting role in resistance modification, extending the minimum value downward. In Set B, lupin was found not to significantly effect either drip or resistance. It was concluded that lupin albumin had a small effect on potato purée quality in a



**Figure 15:** A 3-dimensional plot of maximum resistance in potato purée incorporating a 3-ingredient cryoprotectant mixture (xanthan, carrageenan and lupin albumin).



three ingredient system including xanthan and carrageenan (Figure 15) but none in systems including guar, pectin and whey protein concentrate.

## CRYOPROTECTANT STUDIES WITH APPLE

### Studies with apple purée

Screening experiments were carried out to determine the relative effects of each of the cryoprotectant ingredients on the viscosity, drip loss and colour of apple purées. Blast freezing was used on the basis that it is the main commercial technique used and on its demonstrated superior performance in work on vegetable purées. The results obtained reveal the following:

- (1) xanthan and pectin influenced viscosity
- (2) carrageenan had no effect on viscosity
- (3) sodium caseinate and whey protein concentrate had similar effects on viscosity but the caseinate had an unacceptable effect on apple purée colour.

As a result of this screening experiment, a more focused investigation was carried out using guar, pectin and whey protein concentrate only. With regard to viscosity, results revealed that guar was the most important ingredient while pectin and sodium caseinate were of equal but considerably lower importance. In the case of drip loss, guar was again most important with pectin next; sodium caseinate had no effect on drip after freezing and thawing. Examination of the relationships between these three ingredients in the apple system revealed no interaction. Guar and pectin were the main determinants of both viscosity and drip loss; as shown in Figure 16, the effect of adding sodium caseinate was to increase the range of viscosity slightly.

### Studies with apple purée and lupin protein extracts

Incorporation of globulin extracted from rapeseed affected viscosity and drip loss in apple purées as shown in Figures 17 and 18. It is readily apparent that while the addition of this protein acted to increase purée viscosity in the fresh material, it offered no protection against viscosity reduction after freezing and

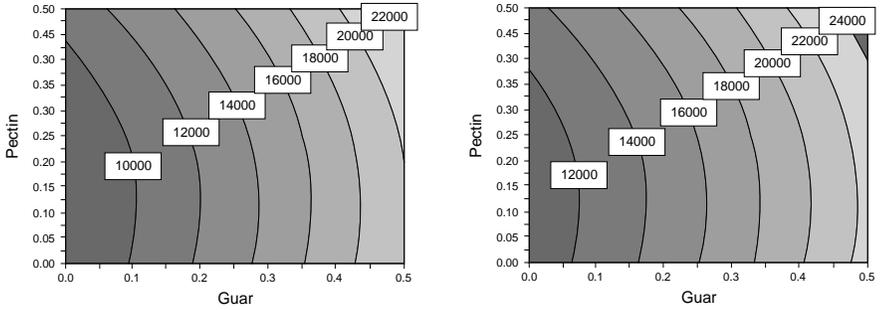


Figure 16: Viscosity (centipoises) of apple purées with varying addition of guar and pectin and at two levels of sodium caseinate incorporation (0 and 1g per 100g purée). Viscosity values are shown in boxes.

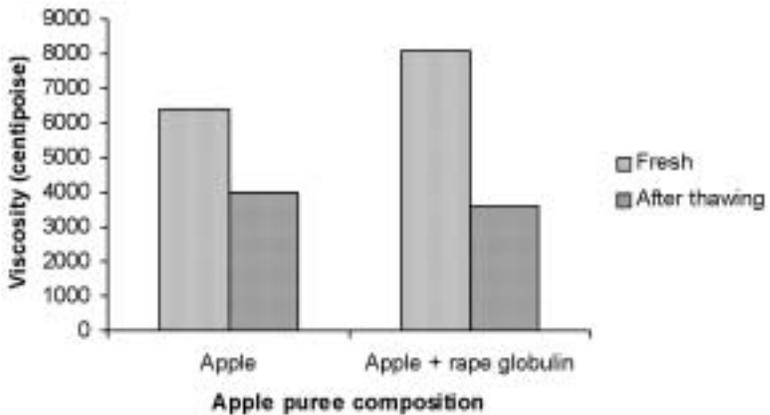


Figure 17. Effect of globulin protein extracted from rapeseed on viscosity of apple purées.

thawing. In the case of drip loss, the observed effects were undesirable, with a major increase in drip loss even in the fresh product. Effects on colour were not of practical significance.

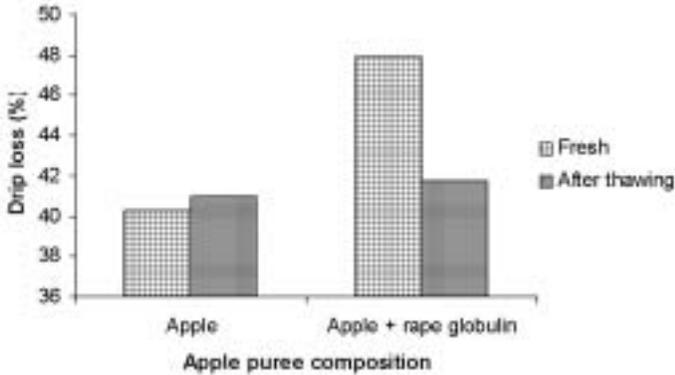


Figure 18. Effect of globulin protein extracted from rapeseed on drip loss of apple purées.

## CONCLUSIONS

- Adding individual cryoprotectants to vegetable (potato, carrot & turnip) and fruit (apple) purées modified drip loss and maximum resistance, depending on the choice of cryoprotectant.
- Vegetable purées without cryoprotectants were generally preferred to those which included them.
- Mixtures of cryoprotectants possess particular functional properties. A strategy for designing purées with desired maximum resistance and minimum drip loss characteristics was developed.
- Novel protein fractions isolated from lupin and rape seeds had no cryoprotective properties in the applications investigated.

## RECOMMENDATIONS TO INDUSTRY

Problems of texture (or body) deterioration and drip build-up can arise with fruit and vegetable components of ready-meals. These problems can be exacerbated if the product is allowed to thaw before domestic use or at point



of retail sale. A number of strategies exist to minimise these problems. Research shows that the more rapid the initial freezing, the better the quality on thawing. The incorporation of cryoprotectant substances can offer additional protection. For most effective control of drip, the use of xanthan or guar gums is best. Softening of product texture can be controlled through the use of these gums or hydrocolloids such as carrageenan or pectin. The particular changes resulting from the incorporation of these cryoprotectants varies with the vegetable or fruit and experimentation is required to determine the optimum usage level on an individual case basis. The use of mixtures of cryoprotectants offers particular advantages in controlling these quality parameters. Using designed experiments, a range of drip loss and texture values may be pre-determined for each individual product. Cost considerations can also be accommodated through this approach. Some negative flavour implications may arise from the use of these substances but they can be overcome through recipe manipulation. Some care may also need to be exercised in cryoprotectant selection as a result of colour considerations e.g. sodium caseinate produces unacceptable colour changes in apple purée.

## ACKNOWLEDGEMENTS

The author wishes to acknowledge the skilled technical assistance of Stephen Flynn, Gráinne Redmond and Estelle Gaspari in the execution of the work described in this report.

## APPENDIX 1

General experimental methods used are described in this section.

Fruit (apples) and vegetables were peeled and diced prior to cooking until tender in boiling water. After mashing to form a purée, cryoprotectants were added in powder form and thoroughly blended. Following an equilibration period of approximately 1 hour, sub-samples of about 400g were transferred into rectangular plastic containers and covered with a tight fitting lid. Lidded containers were then transferred to cabinet or blast freezers as appropriate; after freezing, samples were stored at -20°C for 48 hours. Frozen material was



removed from storage and thawed at room temperature overnight prior to analysis.

Two freezing techniques were investigated *i.e.* cabinet and blast freezing. In the former, vegetable and fruit purées with and without cryoprotectants were frozen by placing in a cabinet freezer at  $-20^{\circ}\text{C}$ ; complete freezing took about 3 hours. Blast freezing was achieved through the use of an air blast at  $-35^{\circ}\text{C}$  and required approximately 1 hour.

Maximum resistance measurements were performed on purées (140-150g) using a Kramer shear press equipped with a specific penetrometer attachment. This comprised a cylinder of Perspex 12.5mm in diameter and 120mm long. The cylinder was attached at one end to a load cell on the shear press. It narrowed to a diameter of 8mm at a distance of 10mm from the free end. Purée samples were placed in a plastic cup (top diameter 6.4cm; base diameter 5 cm; height 5cm) and the maximum insertion distance by the penetrometer set at 5cm. Maximum resistance to penetration was measured in Newtons.

Drip loss was measured by centrifugation of the purée at ambient temperature at 1000g for 10 min. and the weight of supernatant liquid expressed as a percentage of original purée weight.

Colour was measured on a Minolta Chroma meter and expressed as Hunter  $L$ ,  $a$  &  $b$  values.

Sensory tests were performed using an untrained panel of 10 tasters. Normally, six samples were presented to the panellists who were asked to rank them in decreasing order of preference from 1 to 6.

With the exception of the sensory analyses which were not subject to repetition, analyses were performed in triplicate. Appropriate control samples were always included.

# The National Food Centre

RESEARCH & TRAINING FOR THE FOOD INDUSTRY

Dunsinea, Castleknock, Dublin 15, Ireland.

Telephone: (+353 1) 805 9500

Fax: (+353 1) 805 9550



**EUROPEAN UNION**  
European Regional  
Development Fund