VG321
The continuous cooking of onions for food processing and food service application

Penny Hlavaty
Food Design Pty Ltd

Know-how for Horticulture™

VG321

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FINAL REPORT

THE CONTINUOUS COOKING OF ONIONS FOR FOOD PROCESSING AND FOOD SERVICE APPLICATION

PROJECT No.VG321

HORTICULTURAL RESEARCH AND DEVELOPMENT CORPORATION

MASTER FOODS OF AUSTRALIA

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Table of Contents

THE CONTINUOUS COOKING OF ONION FOR

FOOD PROCESSING AND FOOD SERVICE APPLICATION

Executive Summary

The project, ***The Continuous cooking of Onions for Food Processing and Food Service Applications*** was carried out by Food Design Pty Ltd with the assistance of a grant from the Horticultural Research and Development Corporation, supported by Master Foods of Australia. The Food Industry Development Corporation acted as project supervisor.

The aim of the project was to assess the potential for the continuous industrial cooking of onions using a new technology developed by Penny Hlavaty of Food Design. The technology consists of a patented continuous grill, known as the Catergrill, and the cooking techniques developed in conjunction with it.

Practical work on the project commenced in October 1993, using the first prototype of the Catergrill. Market Reaserch was carried out in November 1993 and February 1994. Trials in Year 1 of the project were completed in July 1994.

Year 2 of the project was intended to complete follow-up work on product yield, scaling up to recommended package sizes and economic feasibility studies. This study is not proceeding, as Master Foods prefer to complete this work themselves. This is the Final Report on this project, and details the achievements of the project in its first year.

The project was successful in achieving its aim of demonstrating that a new process for the continuous cooking of onions, using Catergrill technology, is feasible and practical. A variety of onion products were made and assessed for organoleptic quality, shelf life and product safety. Both chilled and IQF products were made and tested. Capsicum products were also tested in similar fashion, but, while easy to process through the Catergrill, were not acceptable, mainly for quality reasons, so work on these products was suspended in April 1994.

This report covers the three aspects of the continuous processing of onions which were examined as part of the project. It is in the form of three separate reports, the first on the Results of the Market Research, the second a Technical Report on the Catergrill, the third a Scientific Report covering food technology issues.

The Market Research survey indicated that there is potential demand for fully-processed onion products, both among manufacturers of further-processed foods and in high volume catering and hospitality industry outlets. It determines consumer preferences, which are primarily for chilled medium diced translucent onion and lightly browned sliced onion, although quite a large selection of products can be sold.

The Technical Report sets out a recommended process for chilled pre-cooked onion products and a similar process for Individually Quick Frozen pre-cooked onion products. The Catergrill works very well, and can produce a product range including the diced and sliced products, as well as innovative products such as very lightly cooked stir-fry style onions and curry base consisting of very finely diced or sliced onion with oil, herbs, spices and flavourings mixed in. All products have a natural appearance, and can hardly be distinguished from traditionally-cooked products. The technical improvements recommended for the Catergrill, to enhance its performance for food manufacture, can be carried out by Food Design's new venture partners, Stainless Associates, who are now working on prototype development.

The conclusions of the Scientific Report are equally positive. Trials on onion products were comprehensive and some procedures were innovative. From these trials it was concluded that IQF pre-cooked onion products were preferable to their chilled equivalents, particularly as there was no visual change to the frozen products, unlike their chilled equivalents, which became more uniform in colour during the effective chilled shelf life of three weeks. However, a technique for chilled acidified onion products was developed, so customers preferring chilled products can be assured of the product's safety as well as convenience. The flavour of the acidified products was still mild and suitable for proposed end uses such as on hamburgers and in sauces and wet dishes.

The main recommendation of this report are that the project proceed towards commercialisation, as there are so far no barriers to success. **This report is to remain confidential on the request of Master Foods of Australia, for two years.**

ONION PROJECT FINAL REPORT

1. INTRODUCTION

In Australia, only five percent of the onion crop is processed into value added product. Most of the processed onion is only peeled, diced or sliced, for sale chilled or frozen to manufacturers and food service operators. This is in dramatic contrast to other basic vegetable crops such as tomato and potato which are further processed in many ways and sold in chilled, frozen, aseptic, bottled, canned and dehydrated forms. It is also in contrast to the USA, where 40% of the crop is dehydrated, 10% peeled or prepared, and some further processed as frozen deep fried onion rings.

Yet, even in countries with a large value-added onion industry, there has previously been no industrially efficient method of continuously cooking a range of onion products in a way that gives similar results in appearance and taste to onion freshly sauteed, stir-fried or barbecued on a griddle.

Even light cooking markedly alters the appearance and flavour profile of the onion. But many food processing factories lack facilities and machinery suitable for frying onion. Where they do attempt it, the steam-jacketed kettles and brat pans commonly used do not give the same results as hand-cooked onion. Many processors use raw onion, supplemented by fried onion or shallot flavours and other flavour compounds in order to replicate the savory quality of cooked onion.

In Food Service operations, larger operators such as food franchises, and large-scale catering and hospitality outlets, purchase quantities of peeled onions and smaller amounts of diced and sliced raw onion. This saves the time taken by staff hand peeling onions. Smaller operators mostly purchase fresh onion, and perceive chilled product as next best to fresh. Yet all sizes of Food Service operations readily purchase frozen potato products, and over half the Australian crop is sold in value added forms.

The project titled ***The Continuous Cooking of Onions for Food Processing and Food Service Applications*** was proposed as a way of pre-cooking onions to achieve both a natural appearance and flavour and a quick and efficient manufacturing process. It utilises a new Australian technology, which comprises the continuous grilling machine known as the Catergrill and the understanding of cooking processes developed by Penny Hlavaty. These are further explained in the Technical Report.

The impact on the onion industry of successful development and marketing of a range of pre-cooked packaged onion products will be radical in the long term. In the same way as the penetration of frozen potato products has been gradual but effective, quality prepared onion products can achieve a large market share, and become the norm in most convenience food operations. Transforming the product gives the chance to transform the economics of the industry by lifting the value of onions from a current contract price of around 12 to 13 cents per kilo, to a fully prepared sale price of around $2 or more per kilo, which exceed the rise in value of frozen potato products.

1.1 LITERATURE SURVEY ON ONIONS AND CAPSICUM

The project commenced with a literature search on both onion and capsicum, as it was intended to run some trials on a variety of capsicum products also. Chilling and freezing techniques were examined as well as food safety and shelf life issues.

The survey commenced with *Critical Reviews in Food Science and Nutrition* , on onions, capsicum, cell damage and water activity. The review on onions was found to be of limited value, as it concentrated on the health and anti-microbial aspects of onion. However, the idea explored in one trial, of using raw onion juice as an anti-microbial agent or preservative for chilled onion products, was influenced by reading the long lists of microbes found to be inhibited by alliums, which include *C. botulinum* and *E coli.*

The review of capsicum concentrated on the study of paprika and oleo resins. These studies are overviews of the typical concerns of scientists studying these vegetables. Few articles were found which dealt with the further processing of onion. Those that were located tended to deal with aspects of the alginate processing of onion rings.

Past issues of onion industry journals were read to gain insight into the onion industry in Australia.

Other searches were mainly into problems and techniques associated with the chilling and freezing of vegetables. These included recent journal articles on vegetable preservation techniques such as vacuum packaging and modified atmosphere packaging, the avoidance of cell damage by good cutting techniques and other quality issues including advanced freezing techniques and IQF machinery.

Microbial spoilage and toxicity in chilled food products was also reviewed. A number of recent articles on Clostridium botulism were studied as it was proposed to vacuum pack onion products. HACCP procedures were studied, as was the prediction of shelf life and microbial growth in chilled foods.

Supplementary research was done during the project as problems were encountered. These included the loss of flavour volatiles, post process contamination and temperature measurement. In these cases, however, the practical answers to the problems were more easily found by questioning experts in the field than in the library.

Legal aspects of chilled and frozen vegetable production in Australia were covered by reference to the Food Code. Good manufacturing practice in chilled and sous vide product manufacture was covered in draft codes of practice and technical instruction manuals in Food Design files.

2.0 METHODOLOGY

The Onion Project was comprehensive in its scope. It covered three main aspects of the establishment of a new value adding agri-food business. Its main aims were to establish:

1) If there is a potential market for pre-cooked onion products.

2) If the Catergrill is a suitable machine to process pre-cooked onion products.

3) That the food science requirements could be met by the suggested process.

These aims were achieved by:

1) Conducting a Market Research survey among manufacturers and food service operators.

2) Trials on the Catergrill at Pacific Power Energy Services showrooms to establish that the desired onion products could be cooked on the Catergrill. These trials determined the time and temperature parameters for cooking the product range.

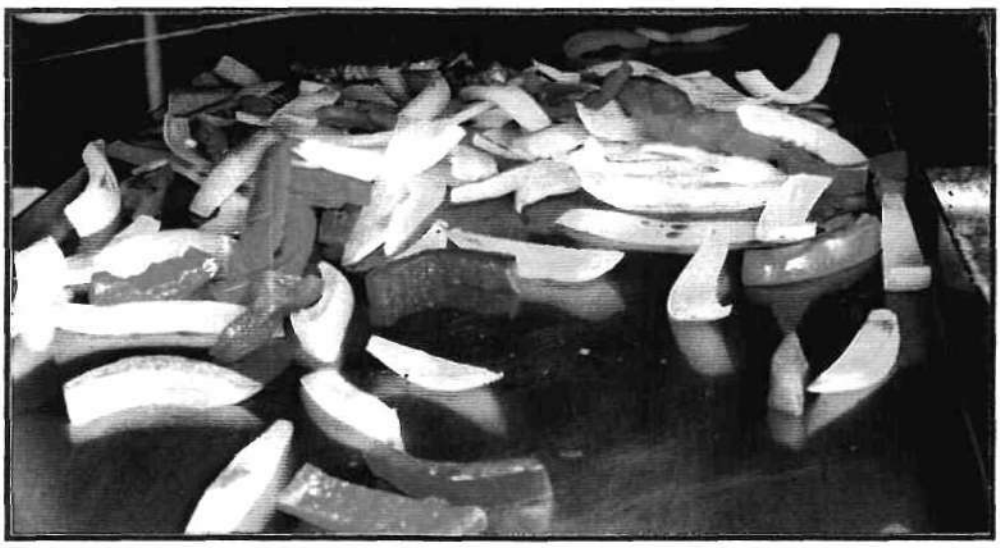
3) Food technology trials carried out at Master Foods of Australia Chilled Food Plant near Wyong, NSW. These included sensory analysis, shelf life testing and microbiology.

The results of these three studies are covered in the three reports which follow.

CATERGRILL PROCESSING OF ONION AND CAPSICUM

Penny Hlavaty with the Catergrill raised to show the two sets of revolving BBQ plates & induction heating coil.

Cut vegetables are fed in one end of the Catergrill



After 1 minute procesing they emerge as stir-fry

3. ONION PROJECT MARKET RESEARCH REPORT

This Market Research Report is part of the results of the project on the Continuous Cooking of Onionsfor Food Manufacture and Food Service, using the Catergrill. The aim of the research was to investigate the extent of demand for the range of cooked and packaged onion products which could be made using the machine.

Two areas of potential demand were identified in preliminary discussions. The first was in the food processing industry, as an improvement to onion flavours and textures for soups, pasta sauces, cook-in sauces, smallgoods and convenience foods. The second was in the Food Service Industry, where demand was forseen in the fast food industries and volume catering.

3.1 METHODOLOGY

Suitable food processing industry and food service respondents were contacted initially by phone. They were chosen through the yellow pages of the capital cities of Australia. The nature of the research was explained to the potential respondent, and a survey form sent to those who were willing to participate. In all, 130 questionnaires were sent, and 50 responses received. This is a response rate of 38.4%, which is excellent, and indicates the degree of interest aroused by the initial contact phone call. Three responses were not fully completed, however, so analysis was conducted on 47 questionnaires. However, in the supplementary report, ***Detailed Analysis of Onion Project Market Research***, which analyses the responses broken down into smaller categories, these responses are included.

The Market Research was carried out in two stages. Manufacturers were contacted first, in November 1993. As this is already peak period for the Food Service industry, and many potential respondents indicated that they were pressed for time, questionnaires for this group were delayed until February.

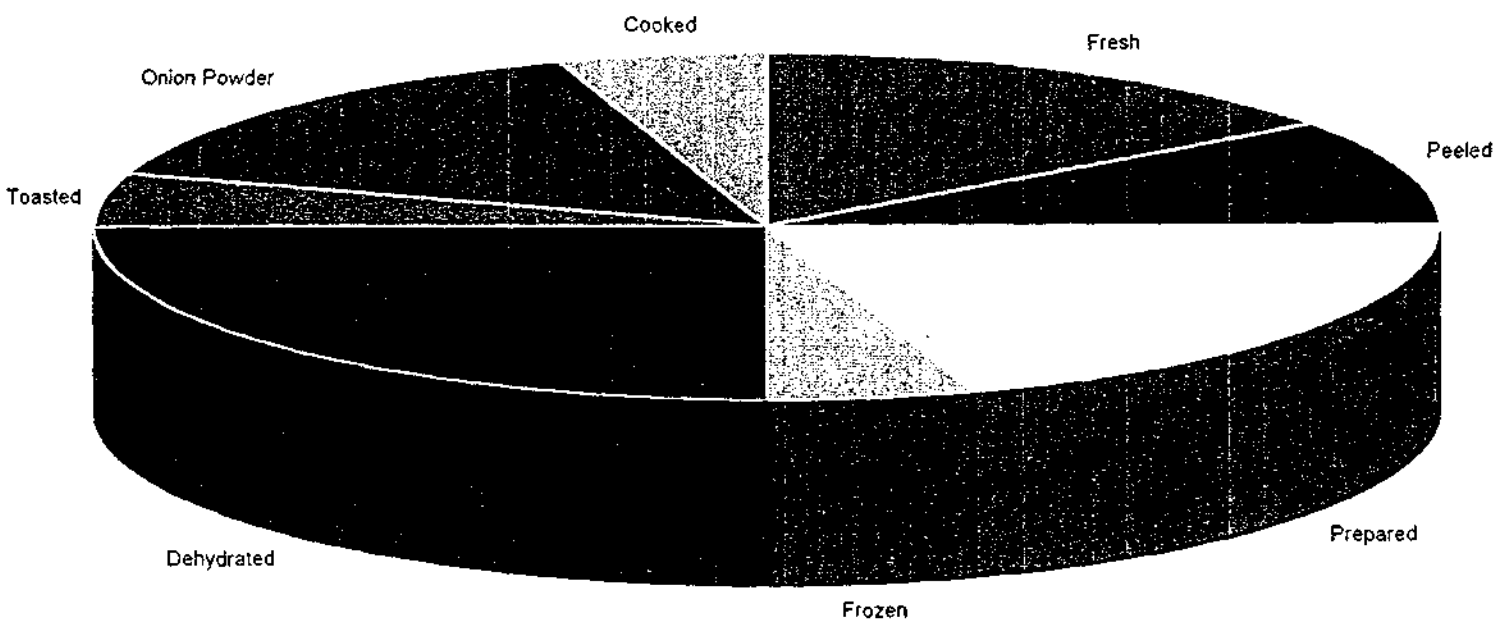
Taking the survey as a whole, 66% of respondents indicated a willingness to purchase one or more of the onion products canvassed in the questionnaire. If this is looked at as a proportion of the 130 questionnaires sent out, then 24% of those approached are potential purchasers.

3.2 FOOD MANUFACTURE

Some idea of the range of manufacturers willing to purchase the pre-cooked onion products is given by the following list of respondents:

Respondent Name	***Type of Business***
Pasta Fina	Pasta Manufacturer
Don Smallgoods	Smallgoods Manufacturer
Kitchens of Sara Lee	Bakery
Beak and Johnson	Cook Chill Specialists for Food Service
Food Partners	Prepared Foods/Meat products
Maison Pate	Smallgoods
Uni-Chef	Portion Control Food for Food Service
Colonial Farm Frozen Foods	Prepared Foods/Meat Products
Your Kitchen	Prepared Meal Systems
Nutrifresh	Cook Chill Production Kitchen
All States Food Service	Prepared Salads

Type of Onion Purchased by Manufacturers Surveyed



At the request of Master Foods of Australia, co-sponsors of this project, no firm involved in any form of manufacture competing with Master Foods brands was contacted. This ment that potential demand from major operators such as Pacific Dunlop, Unifoods, Campbells and their subsidiary companies could not be assessed. This also means that the responses were skewed in favour of medium sized and smaller manufacturers, mainly of cook/chill and similar high value-added foods.

3.3 RESULTS FOR MANUFACTURERS

All manufacturers who responded indicated their willingness to purchase the onion products, with main demand being for 2.5 kg bags and 10 kg bag-in-the-box of translucent medium diced onion, with diced or sliced browned or caramelised onion showing some demand. There was no demand for pallecons of onion products. Both chilled and frozen product are acceptable to the manufacturers, with a preference for chilled.

Interestingly, no manufacturer mentioned price as a determinant for purchase. This may be because they are already accustomed to purchasing a range of value-added onion products depending on specific needs in their product range, ranging in price from $1-$1.80 per kilo for peeled onion, diced onion etc to $18 per kilo for imported toasted onion flakes. Manufacturers are also more skilled at valuing costs of labour versus raw materials.

As the weekly purchase quantity of onion by these manufacturers was from 10 kg to 4 tonnes, this is a market which should be further assessed and for which scaled up product trials should be conducted.

3.4 THE FOOD SERVICE INDUSTRY

The Food Service Industry in Australia is complex and covers many different categories of outlet. It is by convention divided into two segments which are labelled ***Institutional*** and ***Commercial.*** Institutional outlets include health care facilities, educational institutions, prisons, military barracks, industrial canteens and similar operations. Commercial outlets cover restaurants, fast food outlets, hotels, clubs and commercial caterers.

In contacting potential respondents an effort was made to cover the larger scale institutional and commercial operations. Any outlet contacted which used less than one 20 kg sack of onions per week generally did not volunteer to fill in the questionnaire. Responses which were returned were from a range of medium to large Food Service outlets in the following categories:

Institutional Food Service	
Industrial Caterers	5
Airline Caterer	1
Health Care	5
Military	3
Educational Institutions	4
Commercial Food Service	
Clubs	5
Hotels	7
Restaurants	2
Commercial Caterers	6
Fast Food Outlets	2

3.5 RESPONSE IN THE FOOD SERVICE SECTORS

Response in these areas was more patchy overall. The main conclusion is that the larger the operation, the more likely it is to already purchase prepared onion products such as peeled or diced onion, and to convert to the purchase of pre-cooked onion products.

WEEKLY FOOD SERVICE PURCHASES OF ONION

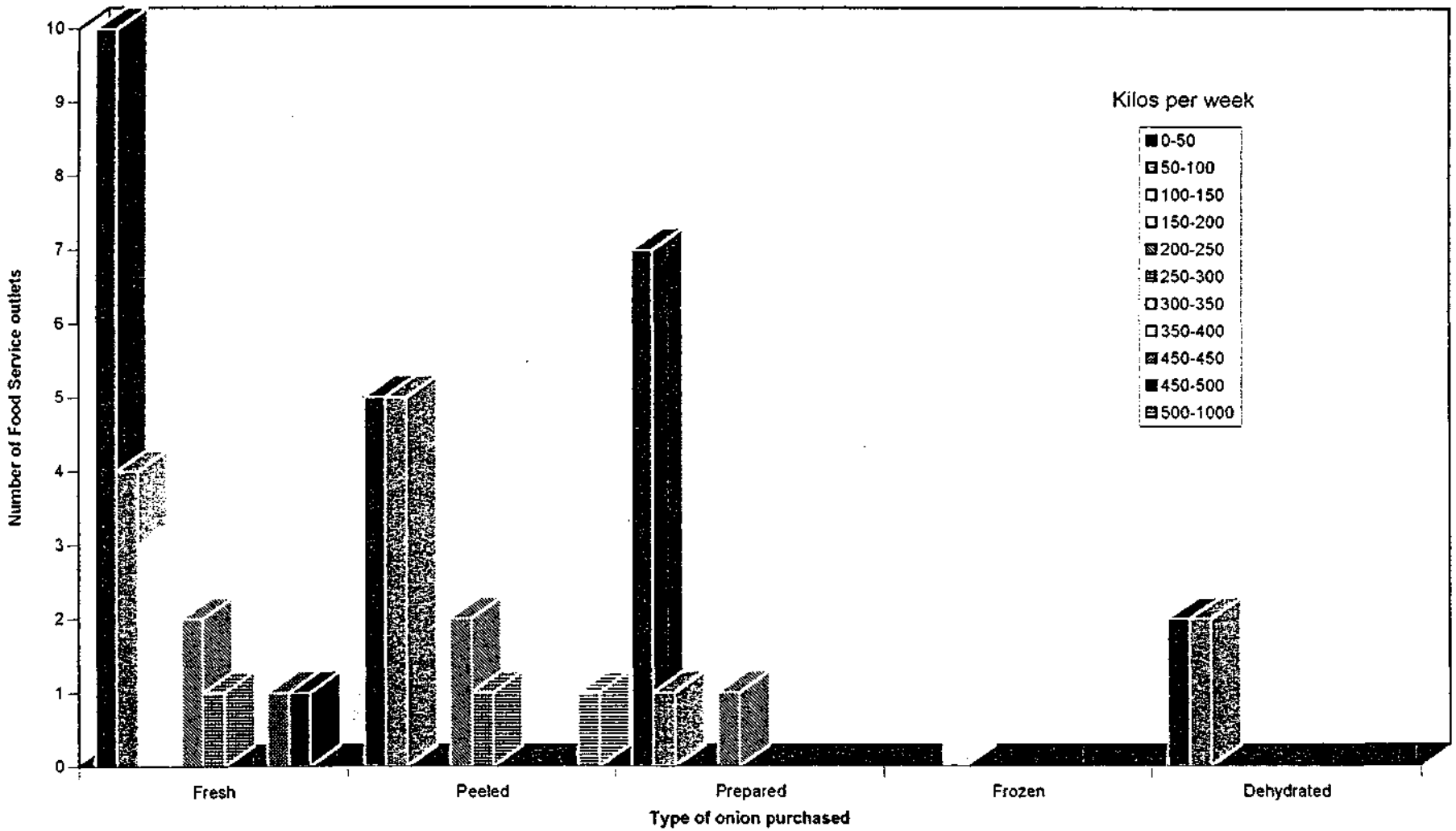
Purchases	Unpeeled	Peeled	Slice/dice	Frozen	Dehydrated
% of users	60%	35%	22%	2%*	10%
av. weight	113kg	149 kg	46 kg	120 kg	n/a
Reported wt	2716 kg	2093 kg	411 kg	120 kg	n/a

(*1 user)

Large institutions are much more likely to use some form of pre-prepared onion. This shows up in the comparison of reported weights used. The average purchase weight of peeled onion is greater than unpeeled. The combined usage of further prepared onion (slice/dice, frozen and dehydrated) is 34%.

Looking closely at usage reported, 60% of establishments used fresh onion, and some used a combination of fresh, peeled and prepared. 35% of establishments brought only peeled or peeled prepared onion.
The market for pre-cooked onion products, then, will initially be among the 35% of larger Food Service institutions and outlets which already use partly prepared onion in preference to unpeeled onion. The raw weight of onion needed to produce the 2624 kg slightly value-added products already exceeds the weight of unpeeled onion used in this sample.

Pattern of Weekly Onion Purchases of Food Service Respondants



3.6 CONCLUSION

From the following analysis of the Market Research for the Onion Project, it can be seen that there is a potential market for chilled or frozen pre-cooked onion products, that this market encompasses both manufacturing and some areas of food service, particularly in large volume outlets. The success of the project will depend on strong marketing in these areas, and on identifying outlets willing to substitute pre-cooked onion for their current purchases of peeled, prepared or dehydrated onion.

The economic analysis in the accompanying Detailed Report strongly suggests that the process for the Catergrill cooking of onion, as described in the Technical and Scientific reports is economically feasible. This can be confirmed by further trials to fully determine weight loss in processing and the study of Master Foods production costs.

Further Market Research will be useful to determine consumer preferences for Catergrill-cooked onion in some areas such as on hamburgers, to assist, in this case, with the replacement of imported dehydrated onion by a new, Australian value added product.

On the basis of this study, the start-up potential for sales to manufacturers is seen as 300 tonnes, or $0.5 m per year. As no figures for the manufacturing use of value-added onion are available, it has not been possible to determine the upper limit. As more value-adding processors come on to the market, or sales to major manufacturers occur, that figure will expand. The potential sales volume in food service is around 2,800 tonnes, or $6.3 m per year.

Ultimately, value-added onion products, including precooked chilled and frozen onion, could achieve sales similar to the proportion of value added potato products, at around 47% of the crop. This would be is 105 kT, of which 20% is 21 kT, or over $40 m.

4. CATERGRILL TECHNICAL REPORT

4.1 THE CATERGRILL

The machine used for this project, ***The Continuous Cooking of Onions for Food Manufacture and Food Service Operations,*** was the first prototype of the Catergrill, which was invented by Penny Hlavaty and built by the Illawarra Technology Corporation. It consists of two endless conveyors which are BBQ plates of mild steel. These are heated before the entry of the food. The individual steel plates store sufficient heat to complete the cooking process.

The uniqueness of this machine lies in two aspects of its design. First, it satisfactorily solves the problem of making a BBQ a continuous cooking device. This allows food to be cooked by direct contact between two metal plates. it is a very favourable system for quickly creating Maillard reactions (browning and caramelisation) on the surfaces of the foods being cooked. This is important for the development of flavours appreciated by man since fire began to be used for cooking.

The second is in the system of remote heating and storage of heat in the steel plates. This means that when food is fed between the two conveyors, the temperature rapidly drops. A searing effect can occur during the first thirty seconds of contact with the food. After that, the food is cooked gently as the heat continues to fall.

The exact fall in temperature depends several factors:

- Chosen start temperature of cooking cycle,
- Duration of cooking.
- Mass of food,
- Initial temperature of food.
- Distance between the conveyors.

These parameters can be manipulated to the advantage of the food items being cooked. Lighter or less dense foods such as vegetables or small particles of meat draw less heat from the plates than large cold pieces such as thick steaks. Although the end temperature of the plates is variable, depending on whether or not there is a food load, and what that load is, it can be regularised on the return journey by controlling the heat source. In a factory situation, when the quantity of food passing through the machine is regulated, the control of temperature is more simple than in a restaurant situation, when various foods are cooked in sequence. The technology of heat measurement and control is now well advanced and reliable.

4.2 ADJUSTMENTS

The adjustments possible on the Catergrill are:

- Initial temperature of the plates, generally in the range of 180° C to 300° C.
- Duration of the cook cycle, which is timed with the speed controller and is usually between 30 seconds and 5 minutes.
- Pressure on the food, which can the adjusted by varying the distance between the conveyors, to press lightly or heavily as desired.

By skilful manipulation of these factors, the degree of cooking of the food can be very finely controlled, and the cycle set up to repeat the results at will.

4.3 THE COOKING AND BROWNING OF ONIONS

Onions are the universal flavouring agent for savoury foods. Their use has spread around the world to the extent that it is almost impossible to imagine cooking any cuisine without them.

Different cuisines have established entirely different uses for onion. The two extremes are represented by Indian cooking, in which diced or finely sliced onion is very slowly cooked with ghee and then with mixtures of ground spice for curries. The absolute contrast is Asian stir-fry cooking, in which large onion flakes or julienne strips are quickly tossed in hot oil so that the onion contributes flavour to the dish without losing its crispness and with minimal colour change.

In some European cuisines, the onion is deliberately caramelised or even blackened, especially for use with hamburgers and BBQ meats. However, the most common European usage is of diced onion, lightly cooked so it becomes translucent and has a milder, sweeter flavour than raw onion.

It is possible to recreate this whole product range using the Catergrill, with results which closely resemble home cooked onion in appearance and flavour.

4.4 TIME/TEMPERATURE TRIALS WITH THE CATERGRILL

The experience of using the Catergrill for the Onion Project showed in which areas the prototype could be effectively improved to make a machine suitable for the continuous production of onion products in the factory.

The project was carried out in two stages. From October to December 1993, and in February 1994, trials were carried out at the premises of Pacific Power Energy Services, generally twice a week. These trials covered the whole range of onion and capsicum products found in cuisines popular in Australia. These were:

- Diced onion, sliced onion, onion rings, char-grilled onion and special Asian cuts.
- Diced capsicum, thick and thin julienne capsicum and antipasto (large rectangles)

These trials were to determine the time and temperature parameters for cooking the products, the likelihood of success with different products, and improvements needed to the machinery.

4.5 MODIFICATIONS TO THE CATERGRILL

As a result of these trials, some modifications were made. These were:

1) The coating of the plates with food grade Teflon to overcome problems caused by onion sticking to the mild steel. The grade of Teflon used was Fluon, a caramel coloured mid-range product chosen because it combined good non-stick properties with resistance to high temperatures.

2) Rectification of electrical safety problems by re-wiring the machine and the provision of safety switches.
3) The replacement of the speed controller, which was erratic, with a more sophisticated model.

4) The provision of stainless steel in-feed and collector trays. While the in-feed tray was useful, the collector chute was not used after problems occurred from time to time when its lip caught between the plates as they rotated.
5) A special coil was ordered from Inductoheat to replace the hand-built coil constructed by Brian Clark of Pacific power. This coil was expected to make adjustments in the distance between the conveyors easier, and to have less losses of magnetic field into the chassis of the Catergrill the original coil. It did improve efficiency but there were several faults in its construction which limited its usefulness and required rectification.

The stainless steel fabrication and electrical re-wiring was carried out by the apprentices at the Sydney Electricity workshops, and was paid for by Sydney Electricity. Their assistance is appreciated. So is the help given by personnel of Pacific Power Energy Services, particularly Brian Clark, who supervised the use of the induction power supply, and the sub-contractor, Mark Griffin, who carried out running repairs to the electrical.

4.6 TRIALS AT MASTER FOODS OF AUSTRALIA

To carry on the project in an true food manufacturing environment, it was necessary to move the Catergrill to Master Foods Chilled Food Plant at Wyong. As the prototype Catergrill was heated by induction, a 15 kW Power Supply unit was leased from Inductoheat. The power supply was plumbed in and the Catergrill recommissioned in March 1994.

In the ten weeks which followed, the intensive trials described in the scientific report were conducted by Penny Hlavaty and Karen Murden, with the assistance of Berowne Hlavaty and Colin Cochrane as Catergrill operators.

While the Catergrill functioned well, except during one three week period, when the induction unit and motor went down in sequence, some technical problems remained. These were:

- The Teflon proved to be less effective than predicted. Small and medium sized diced onion stuck particularly badly although large pieces released well.

- The Teflon also discoloured badly, particularly when the heat was raised for browned onions. Onion juices caramelise very readily in the heat ranges used, so the machine required constant cleaning.

- The gaps between the plates allowed onion to fall through. Some onion also fell off the edges of the plates. Again, the main problem was with the smaller cuts, particularly diced onion. This made measurement of yield impossible. As it had

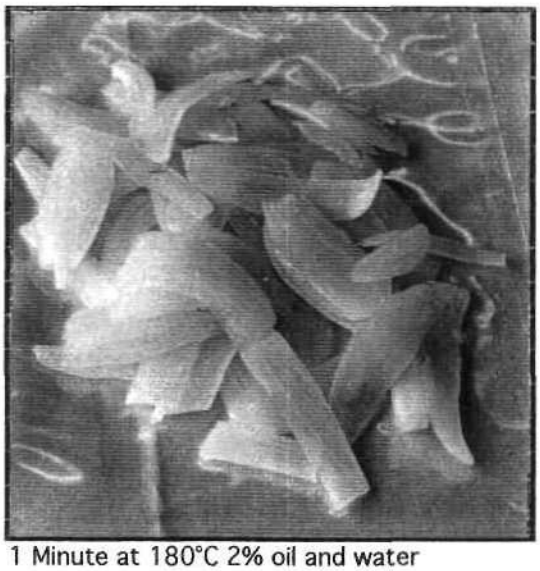
CHANGES IN CUT, TIME & TEMPERATURE GIVE A VARIETY OF RESULTS

3 Minutes at 180°C
Medium diced translucent onion hand cut

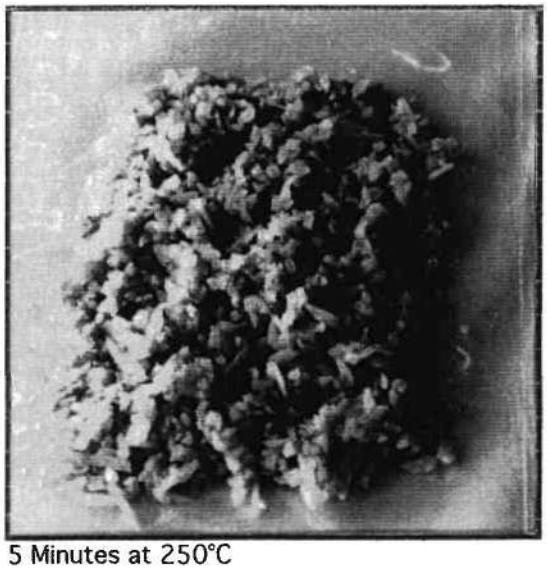
3 Minutes at 220°C
Lightly browned onion strips hand cut

3 Minutes at 220°C 2% oil
Caramelised onion rings mechanically cut

5 Minutes at 230°C 2% oil
Fully caramelised for MFA trials



1 Minute at 180°C 2% oil and water
Lightly oiled Asian julienne



5 Minutes at 250°C
3mm diced onion curry base

been forseen that this might be a problem, that work was to have been done in phase 2 of the project, with the next model Catergrill.

- Capsicum pieces, especially larger cuts, were weighed. They were generally processed for longer times and at higher temperatures than onion, (up to 290° C and 5 minutes for antipasto). their weight loss was from 20-27%. So the shorter, milder onion processes should show 15 -20% weight loss.

4.7 POWER FOR HEATING THE CATERGRILL

The Catergrill can be operated by a variety of heat sources. it is not dependent on the use of induction. it can be adapted to run on gas or radiant or infra red electric elements. The best solution will depend on the usage of the machinery and the criticalness of the cost of power compared to capital. These alternative engineering solutions are currently being designed and trialed. However, for some larger installations induction may still be the best option, as it has flexible response and high efficiency in its favour. in that case, it is recommended that the power supply be remotely located and enclosed, and that the coils be properly shielded to prevent the leakage of magnetic field.

4.8 HEAT MEASUREMENT

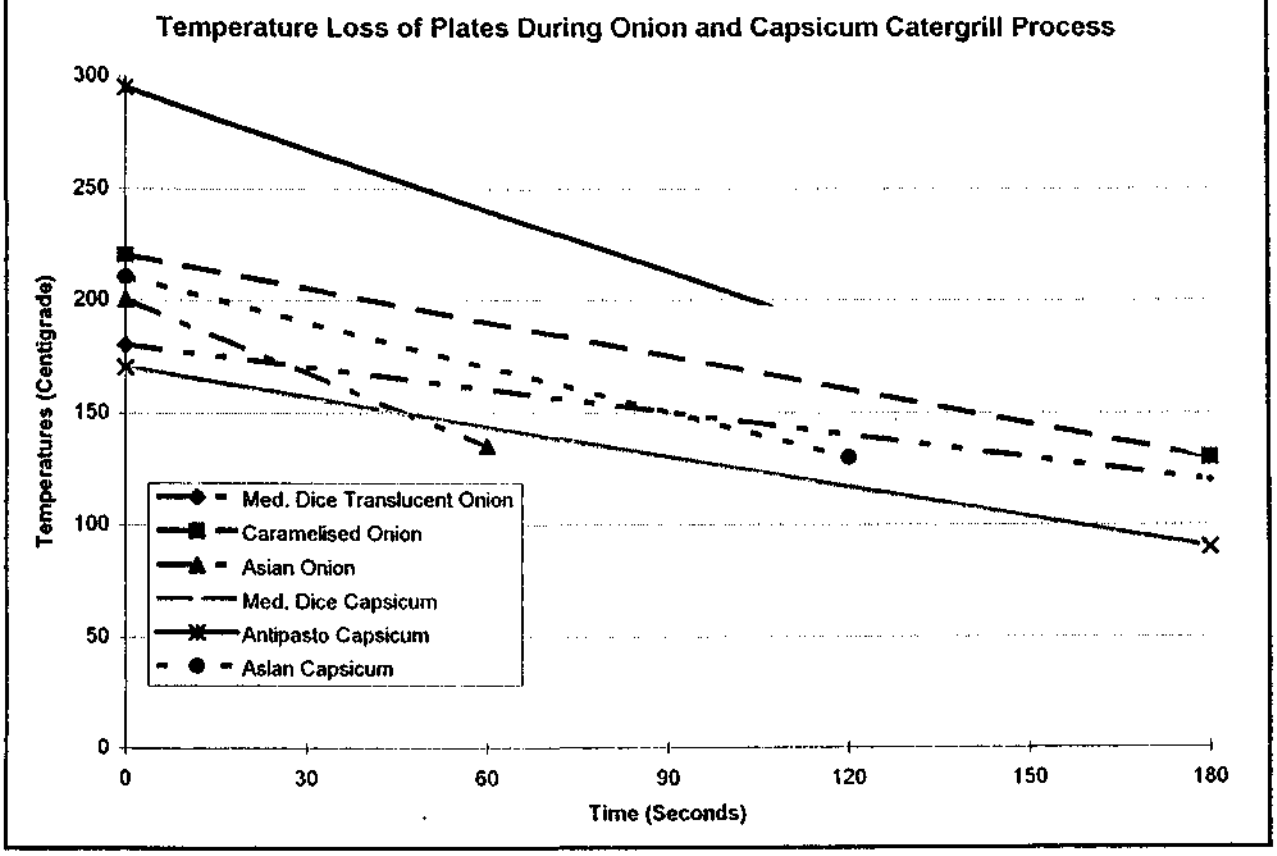
For the measurement of the temperatures of the plates themselves a hand-held Minolta-Land infra-red thermometer was purchased. This is held like a camera and focused on the plate selected. A digital readout records the temperature either continuously or spot as selected. The readout can be calibrated for the emissivity of the surface.

This device was used continuously to check temperatures, so that processing was carried out at the specified temperatures, and adjustments made to the controls on the induction power supply to compensate for changes in load. The infra-red technology proved to be very consistent and reliable, and will be included in future Catergrill designs.

The infra-red thermometer was also used from time to time to assess the temperature of onion and other products emerging from processing. The temperature attained by small samples of onion was close to the desired 70° C.

Accurate temperature measurement is important for the prevention of discolouration by enzymatic browning as discussed in the Scientific Report, and for product safety.
Heat measurement techniques for the products should be further examined and solved when future processing trials are undertaken.

TIME (secs)	0	30	60	90	120	150	180
Med. Dice Translucent Onion	180						120
Caramelised Onion	220						130
Asian Onion	200		135				
Med. Dice Capsicum	170						90
Antipasto Capsicum	295						130
Asian Capsicum	210				130		



4.9 THE PROCESS FOR THE CONTINUOUS COOKING OF ONIONS

The process for the continuous cooking of onions through the Catergrill, which has been intensively studied during this project, is simple and quick. From the results gained in the course of this project the recommended process is:

1) The purchase of peeled but uncut onions, of good quality and free of mould.

2) The washing of the onion prior to further processing in chlorinated water.

3) Mechanical dicing, slicing or Asian-style cutting immediately prior to processing.

4) Mixing with other ingredients in the case of curry blends, or spraying with oil or oil and water for selected products.

5) Process the onion through the Catergrill set to the correct height, temperature and speed.

6) Chill or freeze. Individually Quick Frozen product can be packaged immediately. Chilled product may need the addition of the acid/glucose/Vitamin C mixture described in the Scientific Report.

7) Packaging in appropriate plastic bags. IQF product is not vacuum packed. Chilled product is packed under incomplete vacuum, as complete vacuum crushes the product.

8) Appropriate temperature storage and delivery.

4.10 RECOMMENDATIONS FOR IMPROVEMENTS TO THE CATERGRILL

The following improvements to the prototype Catergrill are recommended for the continuous processing of onion.

1) **The conveyors** should be designed so that the plates fit closely together, so that onion pieces cannot fall between the plates. There should be guard rails along the edges to prevent product from falling off the edges.

2) **The surface coating** of the plates should be changed from the Fluon grade of Teflon used, which was not satisfactory. Advanced non-stick coatings from other manufacturers are being investigated, as well as the French technique of quasi-crystal deposition and nickel or chrome chemical plating. This work will be carried out as part of the development of further Catergrill prototypes.

3) **A hopper and spreader** or waterfall will be needed to control the volume and height of onions entering the machine.

4) **An automatic misting system** will be needed to control the oil or oil/water mix

desirable on some types of onion product. This will not be needed if only frozen onion products are made.

5) **The motor** needs greater reliability than shown by the DC motor on the original Catergrill. If it is a DC motor, a brushless of stepper motor should be used, as it was the brushes and alternator which caused the problems.

6) **Rapid cooling** of the onions prior to freezing will save on freezing costs, particularly if cryogenic rather than mechanical freezing is used, as is likely in the early stages of commercialisation. Cooling can be integrated with the Catergrill by continuation of the process through a cooled double endless conveyor. This option would diminish likelihood of post process contamination.

4.11 CUTTING EQUIPMENT

The quality of the final product will be influenced by cutting equipment more than many other factors. Machinery must be selected for the sharpness of its knives and neatness of its cuts, and maintained well. The major problem to be overcome is the orientation of onions for slices, rings and Asian cuts. Onion samples cut by B & M with existing machinery gave poor results visually when processed (see photo). The product was designated onion slice or rings, but was in fact a mix of slices, dice and fines.

Machinery with parallel knives, such as for slicing calamari, could prove to be adaptable for onion rings. Tomato or apple wedging machines could be adapted for Asian julienne.

CONCLUSION AND RECOMMENDATIONS

This project has been successful in proving that onions can be further processed successfully in the Catergrill, giving a variety of new Food Service products such as medium diced translucent onion, caramelised onion rings and Asian style stir-fried onion.

The onions can be packaged either Individually Quick Frozen, chilled or chilled acidified. While demand as found in the Market Research is predominantly for chilled onion products, it is doubtful if chefs generally understand that for product safety in Australian conditions, the acidified product is almost mandatory. This is particularly because of the uncertainty of correct temperature maintenance along the chill chain. There are also quality reasons for preferring the IQF product, particularly as the chilled onion products change visually over the two to three weeks shelf life, while IQF products maintain the same appearance as at processing.

Research was also conducted on a variety of capsicum products. However there were shelf life problems with the majority of products examined, so this line of research was dropped.

The conclusions of the investigators on this project are that:

1) Market Research indicates that demand for the new products can be created. This demand will be easiest to establish among advanced value-adding manufacturers and large-scale Food Service operators.

2) The Catergrill has the versatility to quickly process the onion products recommended, and all technical problems can be solved by good engineering design.

3) The scientific problems encountered can all be solved, and indications of the direction of future research are outlined in the Scientific Report.

RECOMMENDATIONS

1) That work be continued on the continuous processing of onions to commercialise the process.

2) That a Catergrill prototype specifically designed for onion processing should be designed. This can be done by the new Catergrill manufacturing company currently being formed by Food Design and Stainless Associates.

3) That the second stage of the project, which was to cover yield, economics and scaling up should be continued. Master Foods of Australia has suggested that they can take over these studies and accomplish them , on site, with their own associates.

4) That both chilled and IQF onion products be shown to selected respondents to the Market Research questionnaire, and to other Master Foods clients, to determine true preference and acceptable price points.

5) That capsicum products are not very suitable for precooking by Catergrill process, due to problems encountered in shelf life, chilled preservation and IQF product quality, and that no further study be undertaken on them.

ACKNOWLEDGMENTS

Thanks for assistance with this project are due to the Horticultural Research and Development Corporation and to Master Foods of Australia, who jointly sponsored the grant which made the investigation possible. Particular mention should be made of the helpfulness of Bruce Perkin, Research and Development Director, and Louis Bujega, National Food Service Marketing Manager of MFA, and of the Chill Plant associates who made work on site as pleasant as possible. Janelle Kent assisted with the analysis of the Market research. Dr Peter Cranston of the Food Industry Development Corporation provided expert advice and supervision, especially of Karen Murden, the Honours Graduate Food Technologist who worked closely and excellently with Penny Hlavaty, recorded data and wrote the scientific reports. The role of Pacific Power Energy Services has already been explained and their cooperation is gratefully acknowledged.

Food DESIGN

ONION MARKET SURVEY

Dear participant,
This survey, which you have kindly consented to complete, is part of a unique project which is undertaking to pioneer high quality pre-cooked onion cuts.

The research has been funded by a grant from the Horticultural Research and Development Corporation, and is being carried out by Food Design in consultation with the Food Industry Development Corporation of the University of New South Wales.

The aims of the project are:

* To understand the current market for onions, particularly in areas of high volume food production such as fast food, cook-chill catering and manufacturing.

* To assess the potential for new onion convenience products.

* To produce experimental batches of pre-cooked chilled and frozen onion products through a machine newly developed in Australia. The machine is known as the Catergrill, and is the invention of Penny Hlavaty of Food Design. It combines her chef's skills with state-of-the-art technology, to bring out the best in products cooked in it.

* To scientifically test the shelf-life, taste and product safety of the new range of onion products.

(Cut)----------

Please provide the following details, which will be kept confidential: Return to:
Food Design, 34 Germaine Avenue, Bateau Bay, NSW 2261 by November 30.

Name of organization: _____
Survey completed by: _____
Position: _____
Phone number: ( ) Fax number ( )

Type of business: _____
Annual turnover; _____

General comments: _____
_____
_____

Thank you for your time and attention. Your assistance is appreciated.

FOOD DESIGN PTY LIMITED • ACN 056 695 179 • 34 GERMAIN AVENUE • BATEAU BAY NSW 2261 • AUSTRALIA
TELEPHONE: (043) 34 2541 • FACSIMILE: (043) 34 2903

ONION PROJECT QUESTIONNAIRE

Section 1: Current consumption

1) Do you use onions in your business? Yes☐ No☐

2) Please assist by estimating your consumption.

3) In what form(s) do you buy or

		Weekly purchase quantity kg tonnes
Unpeeled	☐	_____
Peeled	☐	_____
Peeled prepared	☐	_____
Dehydrated	☐	_____
Frozen	☐	_____
Flavours	☐	_____

4) Are all current purchases raw onion? Yes☐ No☐

5) If not, what type of cooked onion do you purchase? _____

Weekly purchase quantity kg tonnes

_____

6) Is this situation convenient for your organization? Yes☐ No☐

7) What aspects of the currrent situation are inconvenient?

a) Time taken to peel/slice raw onion Yes☐ No☐

b) Staff discomfort Yes☐ No☐

c) Shelf life problems with prepared raw onion Yes☐ No☐

d) Other (please specify) _____

Section 2 : Demand for Catergrill Onion Products

8) When high quality convenience products consisting of various types of prepared pre-cooked onion become available, would you purchase them?

Yes☐ No☐

9) If yes, which cuts and sizes would best suit your needs?

	Small	Med	Large
Dice	☐	☐	☐
Slice	☐	☐	☐
Julienne	☐	☐	☐
Rings	☐	☐	☐
Flakes	☐	☐	☐

10) Which degrees of doneness do you prefer?

Still crisp	☐
Translucent	☐
Lightly browned	☐
Caramelised	☐
Blackened	☐

11) What size of packaging is the most convenient for you?

	Chilled	Frozen
1 kg plastic bag	☐	☐
2.5 kg plastic bag	☐	☐
10 kg bag-in-box	☐	☐
Pallecon	☐	☐

12) Which end uses do you see for these products?

Fast food ingredient	☐	e.g, Char grilled rings
Restaurants, hotels, clubs	☐	e.g, Sauteed, stir-fried
Volume and venue catering	☐	
For convenience foods	☐	
Other food manufacturing	☐	e.g, caramelised in soup
Retail sale (smaller pack sizes)	☐	
Other (please specify)	☐	

13) Do you have special needs which can be assisted by this research project?
E.g., Particular onion cultivar, different cut, spiced onion. Please specify.

_____

_____

Thank you very much for your assistance. We appreciate the time you have taken to answer this surve

SECTION 1

	Questions	Responses	% of Total
1)	Do you use onions in your business?		
	Yes	47	100%
	No	0	

2) Estimated weekly consumption (see graph)

	3) In what form(s) do you buy onions?	Responses	% of Total	% of Sample
	Unpeeled	28	41.8	59.6
	Peeled	15	22.4	31.9
	Peeled-prepared	12	17.9	25.5
	Dehydrated	8	11.9	17.0
	Frozen	3	4.5	6.4
	Flavours	1	1.5	2.1
	Total	**67**	**100.0**	**142.6**

Note: some respondants purchase more than one type of onion.

	4) Are all current purchases raw onion?	Responses	% of Total
	Yes	39	83.0%
	No	8	17.0%

5) If not, what type of cooked onion do you purchase?

Fried onion rings	1	Black Stump
Sauteed (diced) onion	2	P&O
Toasted onion flakes (Asian style)	1	
Frozen deep fried onion rings	1	
Onion powder	2	
Dehydrated onion	2	
Not answered	1	Toowoomba Boys Grammar

Note: the only FS purchases were Black Stump and P&O, remainder were manufacturers.

	6) Is this situation convenient for your organization?	Responses	% of Total
	Yes	41	87.2%
	No	6	12.8%

	7) What aspects of the situation are inconvenient?	Responses	% of Total
	a) Time taken to peel/slice raw onion		
	Yes	15	65.2%
	No	8	34.8%
	b) Staff discomfort		
	Yes	11	45.8%
	No	13	54.2%
	c) Shelf life problems with raw onion		
	Yes	11	14.3%
	No	13	85.7%

SECTION 2

8) When high quality convenience products consisting of various types of prepared pre-cooked onion products become available, would you purchase them?

	Responses	% of Total
Yes	31	66.0%
No	9	19.1%
Undecided	7	14.9%
Total	47	100.0%

9) What cuts and sizes would best suit your needs?

	Small	Medium	Large	Total
Dice	14	19	4	37
Slice	6	17	6	29
Julienne	0	7	1	8
Rings	2	12	2	16
Flake	4	3	2	9
Total	26	58	15	99

10) Which degree of doneness do you prefer?

	Responses	% of Total
Still crisp	17	36.2%
Translucent	17	36.2%
Lightly browned	10	21.3%
Caramelised	3	6.4%
Blackened	0	0.0%
Total	47	100.0%

11) What size of packaging is most convenient to you?

	Chilled	Frozen	Total
1 kg plastic bag	11	2	13
2.5 kg plastic bag	14	4	18
10 kg bag-in-box	16	5	21
Pallecon	0	1	1
Total	41	12	53
% preference for chilled or frozen.	77.4%	22.6%	

12) Which end uses do you see for these products?

	Responses	% of Total
Fast food ingredient	15	20.3%
Restaurant, hotels, clubs	13	17.6%
Volume and venue catering	20	27.0%
For convenience foods	7	9.5%
Other food manufacturing	14	18.9%
Retail sale (smaller pack size0	4	5.4%
Other	1	1.4%
Total	74	100.0%

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CONTINUOUS COOKING OF ONIONS FOR FOOD PROCESSING AND FOOD SERVICE APPLICATION

TECHNICAL REPORT

PROJECT No. VG321

Karen Murden BSc (Food Technology) Hons

Table of Contents:

1. Introduction

A process has been devised which makes it possible to cook grilled, barbequed, stir-fry and saute style vegetables in a continuous process. The equipment, known as the Catergrill, allows different cook time and temperature combinations to be used to achieve different results. The process is extremely simple. Vegetables are cut into pieces, placed on the Catergrill, subjected to a process of one to five minutes, then removed from the Catergrill and packed. Other ingredients, such as oil or spices can be added to the vegetable before cooking. After cooking, the pieces can be individually quick frozen or chilled.

This report outlines some basic developmental work which was carried out for the first phase of the project titled ***Continuous Cooking of Onions for Food Processing and Food Service Applications.***

On the basis of preliminary market research work, two onion products were chosen for initial product development work, with the emphasis on developing basic processing guides and examining quality issues. Shelf life experiments have not been conducted, however, estimates of the shelf life of some of the products have been included. Some other onion and capsicum products also show potential and are discussed in less detail.

The first product to be discussed is med-diced translucent onion. This is a lightly cooked saute-style onion, intended for use as an ingredient in sauces, soups, and casseroles. The product is intended for the food service industry, in particular, for catering applications in large institutions. It also has a potential use as an ingredient in food processing, such as in the production of pasta sauces.

The second onion product is caramelised onion rings, a barbecue-style product with a brown appearance and a sweet flavour. This is also intended for food service applications, such as ingredients in hamburgers.

Other onion products which can be produced include chinese style onions, which resemble stir-fry onions and are a possible ingredient in Asian style dishes; and curry onions which are finely diced and heavily seasoned, to be used as a base for curry dishes.

It is also possible to cook capsicum pieces on the Catergrill. Capsicum products which are discussed include a stir-fry mix of capsicum and onion pieces, known as chinese style vegetables, and diced capsicum.

2. Med-diced translucent onion

2.1 Product description

Med-diced translucent onion (MDT) is a lightly cooked saute-style onion. It is made from diced onion pieces, has a pale cream colour and appears slightly translucent. It retains some fresh onion aromas and flavours, but the strong "green" notes of raw onion are lost. It is intended for use as an ingredient in sauces, soups, and casseroles where it should impart an attractive onion flavour which is more mellow than when raw onion pieces are used. The product is intended for the food service industry, in particular, large institutions and mass catering applications. It also has a potential use as an ingredient in food processing, such as in the production of pasta sauces.

2.2 Investigation of product variables

Initial experimental work was carried out with the aim of determining the basic variables to be used in the production of MDT. These included the type of onion to be used, other basic ingredients and processing conditions. A full report of this experimental work is titled ***Med-diced translucent onions: investigation of product variables.***

2.2.1 Raw materials

Product made with brown onion and white onion was compared when fresh and after storage for one to four weeks. Product made with white onion appeared more "white" and less translucent than product made with brown onion, which had a greenish tinge. In addition, the product made with white onion was extremely prone to discolouration, with the product turning an obvious pink colour after one week's chilled storage. White onion also produced a prodcut with a "green" flavour, and a crunchier texture. Brown onions are more commonly used for cooking, and have a more mellow flavour. Brown onions were chosen to be used for production of MDT.

2.2.2 Other ingredients

Translucent onion products can be produced by cooking the onion pieces with or without oil or butter. The addition of fat or oil works as a processing aid, increasing the translucency of the final product and assisting in the removal of the product from the Catergrill plates. A number of different fats and oils were tested, with the following results:

Olive oil: very obvious olive oil flavour comes through
Butter: Butter-cooked product quite likely to develop stale odours after two weeks chilled storage
Blended vegetable oil: In experimental work, product cooked in vegetable oil was generally regarded as having the most acceptable appearance, odour and taste, when compared to MDT cooked with olive oil and melted butter.
No oil: This product was also regarded as having a very acceptable odour and taste, however it has less "translucency" than other products, and lacks their glossy appearance.

A full report of this experimental work, titled ***Comparison of med-diced translucent onion cooked with different oils***, is available.

The amount of oil to be used must be a balance between function and expense. It was found that product cooked with more oil (4%[1]), was more susceptible to the development of rancid flavours than product cooked with less oil (2%). Two percent oil is sufficient to provide the advantages of oil cooking mentioned above.

2.2.3 Cooking conditions

A number of combinations of cook time and temperature were examined. Temperatures of greater than 180°C were found to cause browning of the product, while temperatures lower than this resulted in raw flavours. The most desirable flavours were attained by cooking for 3 minutes[2].

---

[1] All percentages are reported as w/w, unless otherwise stated.

[2] For notes on the measurement of cook time and temperature, see Appendix

The cook time was also found to have an effect on the shelf life of the product. This is thought to be because of the effect of cooking on the antimicrobial compounds naturally present in raw onion. Hence product cooked for longer periods may show signs of breakdown earlier than those cooked for shorter periods.

2.2.4 Packing

Packing the MDT directly from the Catergrill, while it is still hot, was found to produce a better product than if packed cold. Hot-packed product was less likely to suffer from discolouration and gas formation, and, for some products, had more intense odours and flavours.

The product was usually packed into nylon bags, a vacuum of -700 to -800 mbar pulled, and the package then heat sealed.

2.2.5 Chilling and freezing processes

It is possible to produce either chilled or frozen MDT. Chilled product was produced by immersing the freshly packaged MDT in an ice bath for about ten minutes, followed by placing in a cool room operating at 0° - 5° C. For this method of cooling, the product should be spread in a thin layer inside the package and the packages should be placed in the cool room so that air is able to circulate around the packages. This method is only suitable for small volumes of product.

Frozen MDT can be produced by spreading the cooked product thinly in a plastic or metal tray, then putting the tray through a liquid nitrogen cryogenic tunnel, or zip freezer. A temperature of -85°C is sufficient to freeze the pieces in about 6 minutes. Product can then be packaged. Zip freezing produces an extremely convenient product of individual pieces that can be poured directly from the package. Frozen MDT has an attractive appearance when packaged and fresher flavours than chilled product. Upon thawing, the texture of the frozen product is somewhat softer than that of chilled product, however this is still regarded as acceptable. Frozen product was preferred over chilled product by a panel of judges at Masterfoods Australia.

2.2.6 Product parameters

Base ingredients:	Brown onion, diced to 9 mm pieces
	2% blended vegetable oil
Process:	180°C, 3 minutes on Catergrill, followed by chilling or freezing in a cryogenic tunnel
Packing and storage:	Product packaged directly from the Catergrill or after freezing. Stored in refrigerator (4oC) or freezer (-18oC).

2.3 Quality issues

2.3.1 Hygiene

As with all food manufacturing, hygiene is very important. Since the process is quite mild, it is important to keep the microbial load low before the cooking process. Following cooking, the product should be handled as little as possible to avoid contamination.

In early stages of work, some batches of product experienced severe microbial spoilage, with the production of strong "indole" smells. This microbial spoilage appeared to be due to the presence of a large number of Gram negative rods in the product, which was thought to be the result of post-process contamination. The spoiled product did not fluoresce under ultraviolet light, showing that the spoilage was not caused by ***Psuedomonas*** species. Quaternary ammonium compound sanitisers which had been used during production work are inactivated by contact with the cellulose in chux wipes, which had been used to wipe down food contact surfaces. This is thought to be the cause of the spoilage. Other suitable sanitisers are alcohol, chlorine or iodine based. These also have the additional benefit of being more effective on Gram negative bacteria than quaternary ammonium compounds.

During further experimental work, work surfaces were sanitised using undiluted household bleach (4% available chlorine). A one in ten dilution of this bleach was used for dipping peeled onions and for swabbing food contact surfaces.

2.3.2 Raw materials

Med-diced translucent onion (MDT) can be made with brown onions which are freshly diced on site, or with pre-cut onions from another source. For the purposes of commercial production, it may be more economical to use pre-cut onions for the production of MDT. This would mean that the manufacturer would not have to purchase cutting equipment.

MDT produced with pre-cut onions is more likely to have unpleasant bitter flavours than MDT made from freshly cut onion. However, bitter flavours that develop in raw cut onion during transportation and storage may be prevented by acidification to pH 3.9. Thereafter it may be adjusted to normal pH[3]. This project did not examine the use of acidified pre-cut onions.

Although the bitter flavours in pre-cut onions were obvious to trained assessors familiar with the product, it is doubtful whether they represent an important quality issue, considering the end use of the product. For this reason, an experiment was devised with the aim of determining whether or not the average consumer can tell the difference between MDT made with freshly cut onion and MDT made with pre-cut onion. A duo-trio difference test (AS 2542.2.4) was used for this purpose. A full report of this experiment, titled ***Raw materials testing by sensory analysis - med-diced translucent onion***, is available.

The results of the sensory test show that a fair proportion of untrained consumers are able to tell the difference between MDT made with fresh or pre-cut onions. However, this proportion is not high enough to show a statistically significant difference between people's perceptions of the two products.

It can therefore be concluded that, on the basis of taste for fresh MDT, it is quite acceptable to use pre-cut onion supplied by B & M Foods, Alexandria.

Unfortunately, product made with pre-cut onions tends to have other quality defects, related to enzymic browning and microbial status, which will be discussed later. For this reason, the use of pre-cut onions is not recommended unless they conform to strict specifications.

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[3]Schwimmer, S. (1967) Development of a bitter substance in onion juice. *Food Technol.*: 21, 292.

2.3.3 Enzymic browning

Chilled MDT is prone to discolouration during storage. The following are some observations:

Darkening of the product renders it acceptable, due to its unattractive olive green- brown colour, and the loss of translucency.

Darkening begins during storage for less than one week (chilled product).

The product becomes increasingly discoloured with age.

Discoloured product does not necessarily have any other quality defects, with respect to texture, odour or flavour.

Darkening also occurs in product that has been acidified by the addition of lactic acid, however, not as severely as in unacidified product.

Darkening appears to be much more intense in product made with pre-cut onion supplied by B & M Foods. This is especially true for very finely diced onion.

It is thought that darkening of the product is due to enzymic browning because the cooking process for med-diced translucent onions (MDT) is not sufficient to destroy enzymes in the onion pieces. In particular, onion pieces which are in the centre of a thick layer during the process do not reach very high temperatures (<70°C) during cooking.

Enzymic browning in many products is commonly prevented by the addition of ascorbic acid.

It is possible to prevent enzymic browning of MDT by adding 0.05% ascorbic acid after cooking. It is recommended that ascorbic acid be added to MDT if it is to be stored and distributed via a refrigeration chain. This is particularly useful for product made from pre-cut onions, which are more susceptible to browning than freshly cut onions.

Other possible ways to prevent enzymic browning could be the use of sulfur dioxide (SO_2), or increasing the severity of the heat process. An attempt was made to increase the heat penetration through the product by the addition of water to the raw onion pieces. This was designed to cause a blast of steam at the beginning of the cooking process. Unfortunately, this did not appear to greatly increase the final temperature of the product and the method did not prove to be successful in preventing browning.

2.3.4 Development of "off" flavours and odours

Both chilled and frozen MDT can develop "off" flavours and/or odours during storage. Some of these "off" flavours and odours have a rancid character and are believed to be due to autoxidation of the oil added to the product. Product containing larger amounts of oil (4%), or those containing highly flavoured oils such as olive oil or butter, tend to be more effected.

It may be necessary to add antioxidant, either natural (tocopherols) or synthetic (BHA, BHT) to the product in future, depending on the required shelf-life of the product.

Other "off" notes have been described as stale, musty, indole, and are most likely to be the result of microbial spoilage of the product. The "off" notes are usually able to be detected by sniffing the freshly-opened package, but are not usually detectable after reheating of the product. These "off" odours commonly develop after about three weeks storage (chilled).

2.3.5 Loss of flavour and aroma volatiles

Originally, experimental samples were packed into bags made up of the following laminates: nylon/heat-resistant-tie-layer/linear low density polyethylene. This is fairly permeable to oxygen and low molecular weight compounds such as flavour volatiles and aromas.

When examining three week old MDT, it was often found that the product had less intense odours and flavours than fresh product. It appeared to have lost volatiles. In fact, during storage it was possible to smell onion odours through the bags.

An experiment was devised to determine whether high barrier (PVdC[4]) bags are able to retain product aromas better than nylon bags. Products stored for two weeks in the different packages were assessed for aroma and taste. Product stored in high barrier bags was found to have a much fresher, more desirable aroma than product stored in nylon bags. However, the package made little or no difference to the flavour of the reheated product.

It is possible to prevent the loss of aroma by the use of high barrier bags, however, these bags are more expensive than low barrier bags, and make little difference to the taste of the product in its end use.

2.4 Safety

With the recent increase in the number of chilled products available for sale, food microbiologists have raised the issue of the safety of these products. Many of these products are minimally processed and may contain microbial pathogens. These can be a risk to consumers if the products are mishandled, either before or after purchase, or if the food contains a psychrophilic pathogen such as *Listeria monocytogenes*, which is able to multiply in the food under refrigerator conditions. Chilled, cooked onion has been found to be a low acid food, with a pH of approximately 5.9. It therefore has the potential to support the growth of a number of pathogens, including ***Clostridium botulinum***, if subjected to temperature abuse.

By law, vegetables in brine, oil or water must have a pH of < 4.6, if they are not adequately heat processed (Standard F1, 6 (a), Jan 1994). Acidification may be achieved by the addition of the following acids or salts of the same: acetic, citric, fumaric, lactic, malic, tartaric.

In an attempt to lower the pH of the product to safe levels, a number of acidulants were tested on MDT. Acetic acid, citric acid and lactic acid were chosen due to their wide availability and low cost. The acids were added to the MDT both before and after cooking. Acetic acid is not suitable to be added pre-cook because of its volatile nature. The best results, with respect to taste, were achieved by the addition of approximately 0.5% lactic acid, post-cook. This achieves a pH of about 4.3. It is

[4]Poly vinyl di-chloride

also possible to add the acid pre-cook, however this enhances browning of the product during cooking.

Acidified MDT has a sour flavour, which must be counteracted by the addition of a sweetener such as glucose, sucrose, fructose, invert syrup. Glucose was chosen for its flavour and low cost. It was added as a syrup (78%). Best results are achieved by the addition of 1.5% glucose syrup.

Note: It is very difficult to achieve a homogenous product when adding such small volumes of additives to diced onion products. This could present a risk to consumers if pockets of the product are able to retain a pH > 4.6. It is recommended that food acids and other additives be mixed together thoroughly and added to the product in an aqueous solution. The additives should then be thoroughly dispersed by mixing. This aids in the distribution of the acids through the product, and minimises the risk of low-acid pockets occurring.

Acidification is only one of a number of "hurdles" that can be used to increase the safety of the product. Other possible hurdles include: the use of antimicrobials such as sodium nitrite, sulphur dioxide or onion oil; water activity control agents including sodium chloride, poly alcohols and sodium lactate; modified atmosphere packaging; post-process pasteurisation of packaged product; or the addition of lactic acid bacteria which grow during temperature abuse of low acid food and hence prevent formation of ***Clostridium botulinum*** toxin.

These other hurdles were not examined.

2.5 Shelf life

2.5.1 Chilled med-diced translucent onion

The shelf life of chilled MDT is dependent on a number of factors including the initial microbial load the origin of raw materials and the presence of other additives. The main loss of quality during storage is due to enzymic browning, which can occur in less than one week and renders the product an unacceptable brown colour. Browning can be prevented by the addition of 0.05% ascorbic acid.

Chilled samples of MDT containing 0.5% lactic acid, 0.05% ascorbic acid, 1.5% glucose, and 1% water which have been stored for at 0°-5°C for two weeks, have been tasted after reheating and found to have an acceptable flavour with no strong acid notes. The pH of the product was 4.4.

Generally, product which contains lactic acid, glucose and ascorbic acid, can be stored, chilled for three weeks before an obvious loss in quality occurs. This is due to the development of "musty" and "stale" odours, and the physical deterioration of the onion pieces.

It may be possible to extend the shelf life of the product by the use of preservatives, and the use of onion juice as a preservative has been investigated. The antimicrobial properties of raw onion are well documented[5]. The addition of raw onion juice to cooked onion products therefore has the potential to inhibit microbial growth in the product during cold storage and hence enhance its shelf-life.

Initial trials with onion juice showed that the addition of greater than 1% of juice added to the product causes an undesirable taste to be detected. For this reason, a level of 1% was used.

Lactic acid (0.5%), glucose syrup (1.5%) and onion juice (1%) were added post-cook. Onion juice was produced from fresh brown onions in a domestic "vitamiser".

The product was packaged in nylon bags and stored at 0°-5°C for three and five weeks. After storage the product containing onion juice was found to be in better condition than control samples which did not contain onion juice. The samples containing onion juice were also paler in colour than the controls. On the basis of this preliminary work, it appears that onion juice can have a positive effect on the shelf life of the product. It appears to slow bacterial spoilage, but does allow mould growth.

[5]Fenwick, G.R. & Hanley, A.B. (1985) The genus Allium - part 3. *CRC-Crit. Rev. Food Sci. Nutr.* 23:1-74.

2.5.2 Frozen med-diced translucent onion

The shelf life of frozen MDT has not been studied, however, initial observations show that the quality of quick-frozen MDT is retained for at least three months. The expected shelf life for a product of this kind is three to six months.

2.6 Microbiological analyses

Samples of raw diced onion and MDT were examined for total microbial counts, coliforms and yeasts and moulds, to give an idea of what can be expected in these products. The results are shown in Table 2.6.1.

It is important to note that only a very small number of samples have been examined. Hence, the results obtained cannot be assumed to be representative of these onion products as a whole. The figures reported are meant only as a guide, and as a basis for further work.

It appears that med-diced translucent onion may have very high numbers of microorganisms present, even when the product is fresh. These organisms are present in raw cut onion and have been able to survive the relatively mild cooking process. However, the cooking process does appear to succeed in reducing the levels of coliforms and yeasts and moulds to low levels.

Table 2.6.1 Microbiological analysis of med-diced translucent onion produced with the *Catergrill*

	Number of microorganisms present per gram		
Product	aerobic organisms (cfu)[a]	yeasts (cfu)	coliforms (MPN)[b]
Raw diced onion (pre-cut) + 2% oil	6.2×10^5	3.7×10^3	2.1×10^3
Med-diced translucent onion (acidified)	1.0×10^6	<50	<3

a Colony forming units

b Most probable number

A full report on this microbial work, titled ***Microbiological analyses of selected onion products***, is available.

Pre-cut onion was used in this work. It was at least 48 hr old. It is expected that analysis of freshly cut onion would show much lower counts. The counts of the cooked product could then be expected to be reduced. It is recommended that onion used for the production of MDT be cut under hygienic conditions and used as soon as possible after cutting to ensure that the total microbial counts of the product remain low.

In the Australian Food Standards Code, Standard S2, Microbiological requirements for frozen pre-cooked food states that:

(a) 25 g of the food shall be free of Salmonella

(b) total plate count should not be greater than 100,000/g

(c) ***Escherichia coli*** not greater than 9/g

(d) Coagulase positive ***Staphylococcus***, not greater than 100/g.

It should be possible to produce MDT that complies with these requirements, providing that the raw onion is freshly cut, and has been prepared according to good manufacturing practice.

2.7 Recommendations for the production of med-diced translucent onion

High quality med-diced translucent onion (MDT) can be produced on the Catergrill, by a short and simple process. A plate temperature of 180°C, and a cook time of 3 minutes produces a product which is attractive, translucent, firm and tasty.

The raw materials used have a large impact on the quality of the final product, with respect to flavour and shelf-life. MDT can be produced with freshly cut or pre-cut onions. Pre-cut onions are available from B & M Foods. Unfortunately, pre-cut onions are susceptible to bitter flavours and enzymic browning and they may have high microbial counts, hence they are not recommended for the production of MDT. For a high quality product, it is recommended that MDT be produced from large (50 - 60 mm), grade one brown onions, that have been freshly diced under hygienic conditions.

A vegetable oil (2%) can be added, pre-cook, to improve the appearance and mouthfeel of the product and aid in processing. It may be necessary to add antioxidant, either natural (tocopherols) or synthetic (BHA, BHT) to the product, to prevent the development of rancid notes.

As with all food manufacturing, hygiene is very important. Since the process is quite mild, it is important to ensure that the microbial load of the raw materials is low. Work surfaces and food contact surfaces should be clean and sanitised. Onions should be dipped in a dilute chlorine solution after peeling. Following cooking, the product should be handled as little as possible to avoid contamination.

It is recommended that onion used for the production of MDT be cut under hygienic conditions and used as soon as possible after cutting to ensure that the total microbial counts of the product remain low. Minimising the time delay between cutting and cooking will also help to reduce the occurrence of bitter notes in the product.

Following cooking, MDT should be quick-frozen in a liquid nitrogen cryogenic tunnel, followed by packaging in clear, high barrier bags.
The frozen product has an expected shelf life of three to six months.

MDT may also be distributed chilled, however Zip freezing of the product is preferred because it produces a more attractive product with fresher aromas and flavours. The product is also safer, requires no additives, and has a longer shelf life.

Chilled MDT should contain the following additives: 0.5% lactic acid, 1.5% glucose, 0.05% ascorbic acid, 1% water. It is recommended that food acids and other additives be mixed together thoroughly and added to the product as an aqueous solution. The additive solution should then be thoroughly dispersed through the product by mixing. This aids in the distribution of the acids through the product, and minimises the risk of low-acid pockets occurring.

Chilled MDT may be packed in high barrier (PVdC) bags, which prevents the loss of fresh, desirable aromas during storage, however, these bags are more expensive than low barrier bags, and make

little difference to the taste of the product in its end use. Packages should be heat sealed under -700 mbar vacuum.

Chilled MDT has an expected shelf-life of two weeks.

3. Caramelised onion rings

3.1 Product description

Caramelised onion rings (COR) are an onion product produced by cooking onion rings on the Catergrill, giving a "barbecue" effect. The product is a mottled brown and cream colour, and has a sweet flavour. The texture is firm but not crisp. Caramelised onion rings are intended for use as ingredients in hamburgers. They have also been used in the production of Uncle Bens Apricot Chicken, where they imparted slighty stronger onion flavours and fried flavours to the final product than raw onion. There were no differences between the standard raw onion product and product made with Catergrill onion with respect to appearance, texture or mouthfeel. Standard Apricot Chicken was preferred to Apricot Chicken made with Catergrill onion, possibly because stronger fruit flavours are generally preferred in this product[6].

3.2 Investigation of product variables

3.2.1 Raw materials

Caramelised onion rings are produced from fresh brown onions, which have been manually cut into half slices, with the slices then separated into individual half rings. The size of the rings is dependent on the size of the onions used.

[6]Trial conducted by Ben Jackson, R&D, Masterfoods.

3.2.2 Other ingredients

Vegetable oil can be added to the raw onion rings. This gives the finished product a glossy appearance, improves the mouthfeel of the product and allows it to slide easily from the Catergrill. A level of 2% is desirable.

3.2.3 Cooking conditions

Caramelised onion rings are produced by cooking on the Catergrill at a plate temperature of 220°C for 3 minutes. The high temperature results in browning of the product, producing "caramel" aromas and flavours. A three minute cook time is necessary to achieve mellow flavours.

3.2.4 Packing

Caramelised onion rings may be packaged into bags directly from the Catergrill, and cooled after packing by immersion in an ice bath.

The product was usually packed into nylon bags, a vacuum of -700 to -800 mbar pulled, and then heat sealed.

3.2.5 Chilling and freezing processes

It is possible to produce either chilled or frozen COR. Chilled product was produced by immersing the freshly packaged COR in an ice bath for about ten minutes, followed by placing in a cool room operating at 0° - 5° C. For this method of cooling, the product should be spread in a thin layer inside the package and the packages should be placed in the cool room so that air is able to circulate around the packages. This method is only suitable for small volumes of product. During storage of chilled COR, colour bleeding occurs through the onion pieces, resulting in pieces that are a uniform brown colour.

Frozen COR can be produced by spreading the cooked product thinly in a plastic or metal tray, then putting the tray through a liquid nitrogen cryogenic tunnel. A temperature of -85°C is sufficient to freeze the pieces in about 6 minutes. Product can then be packaged. This produces an extremely

convenient product of individual pieces that can be poured directly from the package. Frozen COR has an attractive appearance when packaged and fresher flavours than chilled product. Upon thawing, the texture of the frozen product is somewhat softer than that of chilled product, however this is still regarded as acceptable. Frozen product was preferred over chilled by a panel of judges at Masterfoods Australia because it retains its mottled appearance, and is not susceptible to colour bleed. Care must be taken when handling individually frozen onion rings, as they are susceptible to mechanical damage.

3.2.6 Product parameters

Base ingredients:	Brown onion, cut into 3 mm half rings 2% blended vegetable oil
Process:	220°C, 3 minutes on Catergrill, followed by chilling or freezing in a cryogenic tunnel
Packing and storage:	Product packaged directly from the Catergrill or after freezing. Stored in refrigerator (4oC) or freezer (-18oC).

3.3 Quality issues

3.3.1 Hygiene

As with all food manufacturing, hygiene is very important. It is important to keep the microbial load of the raw cut as low as possible, before the cooking process. Following cooking, the product should be handled as little as possible to avoid cross contamination.

Work surfaces should be sanitised using a suitable sanitiser, such as a sodium hypochlorite solution. A dilute chlorine solution should be used for dipping peeled onions and for swabbing food contact surfaces.

3.3.2 Raw materials

Caramelised onion rings (COR) can be made with brown onions which are freshly cut on site, or with pre-cut onions from another source. For the purposes of commercial production, it may be

more economical to use pre-cut onions for the production of COR. This would mean that the manufacturer would not have to purchase cutting equipment.

Unfortunately, the quality of the raw cut onion used in this work was of a low standard, especially with regard to the shape of the pieces and their flavour. The "rings" were more like shreds of onion, and the size and shape of the pieces was quite variable. The cooked product did not possess the characteristic sweet flavour of COR produced with better quality produce, and some bitter notes were detected.

It is difficult to cut onions into rings using conventional cutting equipment because the onion tends to rotate as it is cut by the rotating blade. However it may be possible to produce rings using a configuration of parallel blades, providing the onion is presented to the blades in the correct orientation. The difficulties associated with producing commercial volumes of cut onion rings is likely to increase the cost of producing this kind of product.

Onion products produced with pre-cut onions are more likely to have unpleasant bitter flavours than those made from freshly cut onion. However, bitter flavours that develop in raw cut onion during transportation and storage may be prevented by acidification to pH 3.9. Thereafter it may be adjusted to normal pH[7]. This project did not examine the use of acidified pre-cut onions.

It is recommended that COR be produced from freshly cut, high quality brown onions. Large onions tend to have a sweeter flavour, and there is less wastage for these onions since they have a greater useable flesh to skin ratio.

3.3.3 Loss of flavour and aroma volatiles

Originally, experimental samples were packed into bags made up of the following laminates: nylon/heat-resistant-tie-layer/linear low density polyethylene. This is fairly permeable to oxygen and low molecular weight compounds such as flavour volatiles and aromas.

[7]Schwimmer, (1967) Food Technol.

When examining COR after storage at 0o - 5oC, it was often found that the product had less intense odours and flavours than fresh product. It appeared to have lost volatiles. In fact, during storage it was possible to smell onion odours through the bags.

An experiment was devised to determine whether high barrier (PVdC[8]) bags are able to retain product aromas better than nylon bags. Products stored for two weeks in the different packages were assessed for aroma and taste. Product stored in high barrier bags was found to have a much fresher, more desirable aroma than product stored in nylon bags. However, the package made little or no difference to the flavour of the reheated product.

It is possible to prevent the loss of aroma by the use of high barrier bags, however, these bags are more expensive than low barrier bags, and make little difference to the taste of the product in its end use.

3.4 Safety

As discussed in section 2.4 above, chilled cooked onion products should be acidified to reduce their pH to less than 4.6. This prevents the growth of ***Clostridium botulinum*** in the product if it is subject to temperature abuse.

Lactic acid at a level of 0.5% has been found to be the most suitable acidulant. This achieves a pH of less than 4.4.

The acid taste in acidified COR can be reduced somewhat by the addition of glucose syrup. In addition, brown sugar added in place of some of the glucose syrup, further enhances the caramelised flavour of this product. Typically, 1% glucose syrup and 0.5% brown sugar are used.

Samples of COR containing 0.5% lactic acid, 1% glucose syrup, and 0.5% brown sugar, have been tasted and found to taste slightly too acid. The pH of the product was 4.1. The strong acid taste can be corrected by raising the pH slightly, however it is important to incorporate a safety margin

[8]Poly vinyl di-chloride

when specifying the pH of products of this type. Overall, the flavour of the COR was found to be quite acceptable for hamburger-type applications.

3.5 Shelf life

3.5.1 Chilled caramelised onion rings

Three week old caramelised onion rings, packaged in nylon bags and stored at 0° - 5°C, have been examined and were found to have an attractive brown appearance, however there was not much aroma, and the high notes had been lost. The flavour and texture were typical and desirable. Five week old product was of a slightly lower quality due to loss of flavour and softening, however it was still found to be acceptable. It was concluded that this product has a potentially good shelf life when stored at 0°-5° C. Note: the product had not been acidified.

Loss of aroma can be prevented by the use of high barrier packaging. This has been discussed in section 3.3.3 above.

Chilled storage of caramelised onion rings results in a change in their appearance, from a mottled cream/brown to a uniform brown colour. This is due to the diffusion of the caramel colour compounds throughout the package. Hence chilled COR has a distinctly different appearance to fresh or frozen product. The uniform brown colour, however, is regarded as acceptable.

3.5.2 Frozen caramelised onion rings

The shelf life of frozen COR has not been studied, however, initial observations show that the quality of quick-frozen COR is retained for at least three months. The expected shelf life for a product of this kind is three to six months.

3.6 Microbiological analyses

Samples of raw onion rings and COR were examined for total microbial counts, coliforms and yeasts and moulds, to give an idea of what can be expected in these products. The results are shown in Table 3.6.1.

It is important to note that only a very small number of samples have been examined. Hence, the results obtained cannot be assumed to be representative of these onion products as a whole. The figures reported are meant only as a guide, and as a basis for further work.

It has been shown that raw onion rings which are produced under hygienic conditions and stored for a minimum amount of time are likely to have low numbers of microorganisms present. Cooking of onion rings is able to reduce the total number of organisms and reduces the number of yeasts and coliforms present to below detectable levels.

Table 3.4.2 Microbiological analysis of caramelised onion rings produced with the ***Catergrill***

	Number of microorganisms present per gram		
Product	aerobic organisms (cfu)[a]	yeasts (cfu)	coliforms (MPN)[b]
Raw onion rings + 2% oil	1.0×10^4	4.5×10^2	2.3×10^1
Caramelised onion rings (acidified)	1.8×10^3	<50	<3

a Colony forming units

b Most probable number

A full report on this microbial work, titled ***Microbiological analyses of selected onion products***, is available.

Caramelised onion rings appear to have much lower numbers of microorganisms present than med-diced translucent onion. This is probably due to the higher cook temperatures used, and the better heat penetration which can occur through the product during cooking, since onion rings are cooked in a less dense layer than diced onions. In addition to this, the raw onion rings had a lower initial load than diced onion, in this case.

3.7 Recommendations for the production of caramelised onion rings

High quality caramelised onion rings (COR) can be produced on the Catergrill, by a short and simple process. A plate temperature of 220°C, and a cook time of 3 minutes produces a product which is attractive, firm and sweet.

The raw materials used have a large impact on the quality of the final product, with respect to appearance and flavour. Caramelised onion rings can be produced with freshly cut or pre-cut onions. Pre-cut onions are available from B & M Foods. Unfortunately, pre-cut onions do not have the characteristic ring shape of manually cut onions. In addition, they are susceptible to bitter flavours and may have higher microbial counts, due to their age. It is recommended that COR be produced only from manually cut, large brown onions, that have been prepared under hygienic conditions. High quality sweet onions produce a desirable sweet product.

Vegetable oil (2%) should be added, pre-cook, to provide a glossy appearance and to improve the mouthfeel of the product. The addition of oil also aids in processing. It may be necessary to add antioxidant, either natural (tocopherols) or synthetic (BHA, BHT) to the product, to prevent the development of rancid notes during storage.

As with all food manufacturing, hygiene is very important. It is important to ensure that the microbial load of the raw materials is low. Work surfaces and food contact surfaces should be clean and sanitised. Onions should be dipped in a dilute chlorine solution after peeling. Following cooking, the product should be handled as little as possible to avoid cross contamination.

It is recommended that onion used for the production of COR be cut under hygienic conditions and used as soon as possible after cutting to ensure that the total microbial counts of the product remain low. Minimising the time delay between cutting and cooking will also help to reduce the occurrence of bitter notes in the product.

Following cooking, COR should be quick-frozen in a liquid nitrogen cryogenic tunnel, followed by packaging in clear, high barrier bags. The frozen product has an expected shelf life of three to six months.

COR may also be distributed chilled, however, the frozen product is preferred due to its superior appearance, aroma and flavour. The frozen product does not require any additives, and has a longer shelf life.

Chilled COR should contain the following additives: 0.5% lactic acid, 1.0% glucose, 0.5% brown sugar. It is recommended that food acids and other additives be mixed together thoroughly and added to the product as an aqueous solution. The additive solution should then be thoroughly dispersed through the product by mixing. This aids in the distribution of the acids through the product, and minimises the risk of low-acid pockets occurring.

Chilled COR may be packed in high barrier (PVdC) bags, which prevents the loss of fresh, desirable aromas during storage, however, these bags are more expensive than low barrier bags, and make little difference to the taste of the product in its end use. Packages should be heat sealed under -700 mbar vacuum. Chilled COR has an expected shelf-life of three weeks.

4. Other onion products

4.1 Chinese style onions

4.1.1 Product description

Chinese style onions resemble a stir-fry product, in which the onion is cut in wide strips. It has a firm texture, pale colour and strong onion flavour. It can be added directly to stir-fry style dishes or used to produce Asian sauces, where it may be able to impart a better flavour than raw onion.

4.1.2 Product parameters

Onion pieces are prepared by topping onions, cutting in half longitudinally, peeling, then cutting into 20 mm wide slices longitudinally. The slices are then separated into individual segments. The pieces are sprayed with 2% oil/water mix (1:1), then cooked on the Catergrill at 200°C for 1 minute. Following cooking they may be zip frozen or chilled.

4.1.3 Recommendations for the production of chinese style onions

These onion pieces have an extremely attractive appearance, aroma and flavour. They are able to be produced very quickly. Due to their high pH, it will be necessary to acidify the product if it is to be distributed chilled. The frozen product is preferred, for its appearance and flavour.

4.2 Curry onions

4.2.1 Product description

Curry onions, are a highly flavoured onion product, designed as a base for curries. They are produced by combining finely diced onion with butter flavours, curry spices and vegetable oil, and cooking very slowly to achieve a desirable caramel, "cooked curry" flavour.

4.2.2 Product parameters

Due to the strong flavour of the finished product and its anticipated end use as a curry ingredient, it is acceptable to produce curry onions using lower quality raw cut onions, such as those available from ***B & M.***

Curry onions were produced by mixing dry ingredients with raw shredded onion, followed by cooking for five minutes at high temperature on the ***Catergrill.***

Table 4.1 Formulae for two varieties of curry onions

	(g)	
Ingredient	#1	#2
onion	2000	2000
vegetable oil	160	250
butter flavour (powdered)	8	25
Masterfoods curry powder	300	500
freshly chopped ginger	100	78
freshly chopped garlic	100	120

4.2.3 Performance of curry onions

Catergrill curry onions were given to Ben Jackson (R&D, *Masterfoods*) for trials in Uncle Ben products. It was used in a mild curry sauce prototype and compared with product made with raw onion. The Catergrill product was found to be darker in colour and had a significantly less "grainy" mouthfeel than the other prodcut. It was also found to have a more balanced curry flavour. There was no difference between the onion flavour of the two products. Catergrill curry onions are seen as

having definite advantages over raw onions in this type of product, as they lack the "raw" curry profile often found in these products.

5. Capsicum products

5.1 Chinese vegetables

5.1.1 Product description

Chinese vegetables resemble a stir-fry product, in which brown onion, red capsicum and green capsicum are cut into strips and combined in a ratio of 2:1:1. The product has an extremely attractive appearance, firm texture, and attractive flavours. It can be used as a side dish.

5.1.2 Product parameters

Onion pieces are prepared by topping onions, cutting in half longitudinally, peeling, then cutting into 15 mm wide slices longitudinally. The slices are then separated into individual segments. Capsicum pieces are prepared by slicing capsicum longitudinally. The pieces are combined and sprayed with 2% oil/water mix (1:1), then cooked on the Catergrill at 200°C for 1 minute. Following cooking they may be zip frozen or chilled.

5.1.3 Recommendations for the production of chinese style onions

These onion pieces have an extremely attractive appearance, aroma and flavour. Even after storage for eleven days at 4o C, they still retain fresh flavours. No colour bleeding or flavour mixing problems were observed. Further work is needed to determine whether this product can be successfully zip frozen.

5.2 Capsicum pieces

It is possible to cook capsicum pieces on the Catergrill, using temperatures around 200oC and cook times of approximately 1 minute. The capsicum pieces resemble stir-fried or roasted capsicum. They may be packaged directly into clear bags for chilling or may be packed in oil. Cooked capsicum

products are susceptible to the development of bitter flavours. Green capsicum products tend to lose their bright green colour and turn a khaki colour.

6. Conclusion

It is possible to produce a wide range of cooked onion products, by a continuous process using the Catergrill. Products that have been studied include med-diced translucent onion, caramelised onion rings, chinese style onion, and curry onions. All these products are produced by a simple and quick process and have desirable characteristics.

Used in Uncle Bens products, Catergrill onions are able to impart genuine fried flavours and improve flavour profiles.

Appendix

Measurement of cook time of Catergrill products:

Cook time is a measure of the amount of time that product was in contact with Catergrill cooking surfaces. It is directly proportional to the speed settings on the Catergrill conveyor. The cook time corresponding to each speed setting was determined by measuring the amount of time taken for a point on the conveyor chain to pass between two marks a known distance apart on the machine structure. This time was designated the calibration time. The cook time was related to the calibration time by a formula, which assumed that the distance travelled by a piece of onion while in contact with the Catergrill cooking surfaces was equal to 850 mm.

Measurement of cook temperature of Catergrill products:

Cook temperature was designated to be the temperature of the Catergrill plates immediately before contact with the onion pieces. Obviously, the temperature of the plates drops considerably after contact with food. The temperature of the plates was measured using a hand held, infra red optical thermometer. These are designed to measure the temperature of reflective surfaces and have to be adjusted according to the emissivity of the surface being measured. There is some doubt as to the

accuracy of readings taken with this device, because the emissivity of teflon coated steel plates is not known.

The temperature of individual plates on this Catergrill model can be extremely variable, and there can also be significant differences between the temperature of top and bottom plates, although these differences were kept to a minimum whenever possible. Hence it was not possible to achieve the exact temperatures quoted in this report. The cook temperatures quoted are meant as a basic guide, and it is possible to achieve acceptable results with variations of 5° - 10° C.

DESIGN

ONION MARKET SURVEY

Dear participant,
This survey, which you have kindly consented to complete, is part of a unique project which is undertaking to pioneer high quality pre-cooked onion cuts.

The research has been funded by a grant from the Horticultural Research and Development Corporation, and is being carried out by Food Design in consultation with the Food Industry Development Corporation of the University of New South Wales.

The aims of the project are:

* To understand the current market for onions, particularly in areas of high volume food production such as fast food, cook-chill catering and manufacturing.

* To assess the potential for new onion convenience products.

* To produce experimental batches of pre-cooked chilled and frozen onion products through a machine newly developed in Australia. The machine is known as the Catergrill, and is the invention of Penny Hlavaty of Food Design. It combines her chef's skills with state-of-the-art technology, to bring out the best in products cooked in it.

* To scientifically test the shelf-life, taste and product safety of the new range of onion products.

(Cut)----------

Please provide the following details, which will be kept confidential: Return to:
Food Design, 34 Germaine Avenue, Bateau Bay, NSW 2261 by November 30.

Name of organization: _____
Survey completed by: _____
Position: _____
Phone number: ( ) Fax number ( )

Type of business: _____
Annual turnover; _____

General comments: _____
_____
_____

Thank you for your time and attention. Your assistance is appreciated.

FOOD DESIGN PTY LIMITED • ACN 056 695 179 • 34 GERMAIN AVENUE • BATEAU BAY NSW 2261 • AUSTRA
FACSIMILE (043) 34 9903

ONION PROJECT QUESTIONNAIRE

Section 1: Current consumption

1) Do you use onions in your business? Yes☐ No☐

2) Please assist by estimating your consumption.

3) In what form(s) do you buy or

		Weekly purchase quantity kg tonnes
Unpeeled	☐	_____
Peeled	☐	_____
Peeled prepared	☐	_____
Dehydrated	☐	_____
Frozen	☐	_____
Flavours	☐	_____

4) Are all current purchases raw onion? Yes☐ No☐

5) If not, what type of cooked onion do you purchase? _____

Weekly purchase quantity kg tonnes _____

6) Is this situation convenient for your organization? Yes☐ No☐

7) What aspects of the currrent situation are inconvenient?

a) Time taken to peel/slice raw onion Yes☐ No☐

b) Staff discomfort Yes☐ No☐

c) Shelf life problems with prepared raw onion Yes☐ No☐

d) Other (please specify) _____

Section 2 : Demand for Catergrill Onion Products

8) When high quality convenience products consisting of various types of prepared pre-cooked onion become available, would you purchase them?

Yes☐ No☐

9) If yes, which cuts and sizes would best suit your needs?

	Small	Med	Large
Dice	☐	☐	☐
Slice	☐	☐	☐
Julienne	☐	☐	☐
Rings	☐	☐	☐
Flakes	☐	☐	☐

10) Which degrees of doneness do you prefer?

Still crisp	☐
Translucent	☐
Lightly browned	☐
Caramelised	☐
Blackened	☐

11) What size of packaging is the most convenient for you?

	Chilled	Frozen
1 kg plastic bag	☐	☐
2.5 kg plastic bag	☐	☐
10 kg bag-in-box	☐	☐
Pallecon	☐	☐

12) Which end uses do you see for these products?

Fast food ingredient	☐	e.g. Char grilled rings
Restaurants, hotels, clubs	☐	e.g. Sauteed, stir-fried
Volume and venue catering	☐	
For convenience foods	☐	
Other food manufacturing	☐	e.g. caramelised in soup
Retail sale (smaller pack sizes)	☐	
Other (please specify)	☐	

13) Do you have special needs which can be assisted by this research project?
E.g., Particular onion cultivar, different cut, spiced onion. Please specify.

_____

_____

Thank you very much for your assistance. We appreciate the time you have taken to answer this surv

SECTION 1

Questions	Responses	% of Total
1) Do you use onions in your business?		
Yes	47	100%
No	0	

2) Estimated weekly consumption (see graph)

3) In what form(s) do you buy onions?	Responses	% of Total	% of Sample
Unpeeled	28	41.8	59.6
Peeled	15	22.4	31.9
Peeled-prepared	12	17.9	25.5
Dehydrated	8	11.9	17.0
Frozen	3	4.5	6.4
Flavours	1	1.5	2.1
Total	**67**	**100.0**	**142.6**

Note: *some respondants purchase more* than one type of onion.

4) Are all current purchases raw onion?	Responses	% of Total
Yes	39	83.0%
No	8	17.0%

5) If not, what type of cooked onion do you purchase?

Fried onion rings	1	Black Stump
Sauteed (diced) onion	2	P&O
Toasted onion flakes (Asian style)	1	
Frozen deep fried onion rings	1	
Onion powder	2	
Dehydrated onion	2	
Not answered	1	Toowoomba Boys Grammar

Note: the only FS purchases were Black Stump and P&O, remainder were manufacturers.

6) Is this situation convenient for your organization?	Responses	% of Total
Yes	41	87.2%
No	6	12.8%

7) What aspects of the situation are inconvenient?	Responses	% of Total
a) Time taken to peel/slice raw onion		
Yes	15	65.2%
No	8	34.8%
b) Staff discomfort		
Yes	11	45.8%
No	13	54.2%
c) Shelf life problems with raw onion		
Yes	11	14.3%
No	13	85.7%

SECTION 2

8) When high quality convenience products consisting of various types of prepared pre-cooked onion products become available, would you purchase them?

	Responses	% of Total
Yes	31	66.0%
No	9	19.1%
Undecided	7	14.9%
Total	47	100.0%

9) What cuts and sizes would best suit your needs?

	Small	Medium	Large	Total
Dice	14	19	4	37
Slice	6	17	6	29
Julienne	0	7	1	8
Rings	2	12	2	16
Flake	4	3	2	9
Total	26	58	15	99

10) Which degree of doneness do you prefer?

	Responses	% of Total
Still crisp	17	36.2%
Translucent	17	36.2%
Lightly browned	10	21.3%
Caramelised	3	6.4%
Blackened	0	0.0%
Total	47	100.0%

11) What size of packaging is most convenient to you?

	Chilled	Frozen	Total
1 kg plastic bag	11	2	13
2.5 kg plastic bag	14	4	18
10 kg bag-in-box	16	5	21
Pallecon	0	1	1
Total	41	12	53
% preference for chilled or frozen.	77.4%	22.6%	

12) Which end uses do you see for these products?

	Responses	% of Total
Fast food ingredient	15	20.3%
Restaurant, hotels, clubs	13	17.6%
Volume and venue catering	20	27.0%
For convenience foods	7	9.5%
Other food manufacturing	14	18.9%
Retail sale (smaller pack size0	4	5.4%
Other	1	1.4%
Total	74	100.0%

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