



Know-how for Horticulture™

**Developing strategies
to stimulate local
consumption, export
and import
replacement of globe
artichokes**

Fouad H. Gaoubran *et al*
Natural resources and
Environment
Horticulture Australia
Limited

Project Number: VG99030

VG99030

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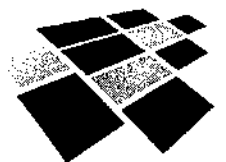
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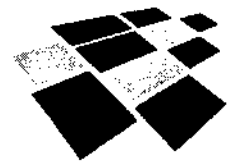
DEPARTMENT OF
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The Globe Artichoke: A strategy to stimulate local consumption, export and import replacement.

Final report for the project VG99030 (December 2001)

Fouad H.Goubran *et al*

**Research Provider:
Natural Resources and Environment
Horticulture Australia Limited**



Horticulture Australia

HORTICULTURE AUSTRALIA LIMITED

FINAL REPORT

December 2001

Project Title: The Globe Artichoke: A strategy to stimulate local consumption, export and import replacement.

Project No.: VG99030

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Purpose of the report: Reporting the findings of an investigation into the status of the globe artichoke industry in Australia and propose a value-adding strategy aimed at increasing consumption and raising the profile of globe artichoke.

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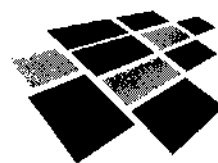
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1. Media Summary

Statistics indicate that the Australian production and consumption of globe artichokes have not kept pace with the increase that has taken place with other vegetable crops. This static state of affairs could be attributed to a number of reasons. These include unfamiliarity of the majority of consumers with this vegetable, its use and/or difficulty in its preparation, competition from processed products and lack of promotion. This is despite the crop's culinary versatility, excellent nutritional value and potential export prospects.

Presently, the globe artichoke industry is small. However, it has the potential to expand considerably over the next few years. Australia is currently a net importer of artichoke products to meet the needs of consumers and a small local processing industry that relies on imported canned artichokes as primary material for its anti-pasto and related products. These products are marketed locally and/or exported at a much higher price than the imported primary material.

The aim of this project was to:

- Identify barriers obstructing the local expansion and export market opportunities for globe artichokes
- Develop a protocol for a frozen artichoke product
- Assess the consumers acceptance of such a product
- Document to growers the benefits of a processed product as a viable and complementary alternative to their present focus on a limited fresh market.

This project has shown that value adding (eg. freezing artichoke hearts) is technically feasible for globe artichoke and that its commercial acceptance would considerably boost the local consumption in both the retail markets and food service sector. The project has also demonstrated that a cooked and frozen artichoke product that is ready to heat and eat would also be highly acceptable to the markets locally and overseas. Given the health benefits and nutritional value of artichokes, the export opportunities will be also enhanced in the health conscious and expanding Asian markets.

Further work is required to bring this concept to realisation and adoption by the processing industry. Moreover, in order to achieve this aim the artichoke industry will need to re-assess its existing local fresh market orientation and re-adjust itself to meet the expected requirements of a local processing industry.

2. Technical Summary

The volume and variety of vegetables offered to Australian consumers have increased dramatically over the last 20 years. However, the production of globe artichoke has remained to a large extent, almost static at between 500 and 1500 tonnes for decades. This situation reflects limited consumption, which can be attributed to unfamiliarity and/or difficulty in the preparation and use of artichokes. This is despite the crop's culinary versatility, excellent nutritional value and potential export prospects. As well as pursuing opportunities to increase local consumption, there is also a need to address export and import replacement opportunities.

Australia is currently a net importer of processed artichoke products to meet consumers' needs and to support a small processing industry that relies on canned artichokes for the production of anti-pasto products. Such products are marketed locally and/or exported at a much higher price than the imported primary material. Furthermore, there is a certain lack of vision in addressing the export opportunities and economic consequences of adopting new value adding and marketing strategies that are at the moment untapped by growers and processing firms.

The aim of this project was to:

- a) Describe the current state of the globe artichoke industry and identify the barriers obstructing the increase in local consumption and export opportunities,
- b) Develop a protocol for a frozen artichoke and other value-added products,
- c) Assess consumer's knowledge of fresh artichoke and acceptance of value-added products and
- d) Document to the industry the achievable benefits of processing as a viable and complementary alternative to its present focus on the fresh market.

The nature of this investigation dictated the use of four different research methodologies that focussed on: a) Collecting quantitative information and statistics by interviewing growers and food service operators to ascertain their views on their respective industries and future vision; b) Experimenting with various anti-browning and processing treatments to test their efficacy in controlling enzymatic browning of fresh artichoke hearts destined for processing by freezing; c) Determining consumers' acceptance of a processed products through panels of assessors asked to indicate their level of preference for some sensory characteristics of the processed product and d) Documenting the economic benefits to the artichoke industry and reviewing its capacity to accommodate a local processing industry as a viable and complementary alternative to its present focus on the small and static fresh market.

Our investigation showed that the artichoke industry in Australia is small by world standards and consists mainly of traditional family farm units clustered in Victoria where 90% of the annual crop (1300 tonnes) is produced. Production varies from year to year depending on the number of growers entering or exiting the industry. The bulk of the production is destined for the local fresh market with sporadic exports to hospitality trades in the Asia/Pacific region.

An estimated 700 tonnes of processed artichoke products are imported annually to satisfy mainly the need of a local processing industry. The reliance on imported material is due to a shortage of local supply and the cheaper prices of overseas products. However, local processors have expressed interest in buying locally, provided they can be guaranteed a continuation of supply at prices comparable to the imported material.

Besides the possibility of achieving import replacement, our investigation also showed that some value adding concepts such as plain frozen artichoke hearts (ready to cook) as well as cooked and frozen versions (ready to heat and eat) are technically feasible, convenient for consumption and accepted by consumers. Such concepts, if adopted, would considerably improve the local marketability and increase the export potential of globe artichokes.

Further work is required to bring the value adding concepts reported in this project to realisation and commercial adoption by the processing industry. Moreover, in order to help achieve this aim, the artichoke industry will need to re-assess its existing local fresh market orientation and re-adjust itself to meet the expected increase in requirements of a local processing industry. Paramount in this regard will be issues such as introduction of varieties suitable for processing, mechanisation, seasonality and economies of production among other issues.

Despite its small size by world standards, the Australian artichoke industry has the necessary expertise and capacity to expand if these and new market opportunities are exploited to their full potential.

3. Literature Review

3.1 Introduction

While the volume and variety of vegetables offered to Australian consumers have increased dramatically over the last 20 years, the interest in some such as the globe artichoke has remained almost static. This is in spite its versatility as a vegetable and its well documented excellent health benefits. In Australia, the interest in globe artichoke (particularly in its fresh form) remains largely restricted to particular ethnic groups who are familiar with its use. This could be attributed to a number of reasons such as unfamiliarity of the majority of consumers with this vegetable, difficulty in its preparation, competition from processed forms of the product and lack of promotion of artichokes on domestic markets.

This project aimed at: a) Describing the current status of the Australian globe artichoke industry and identifying the major barriers to its expansion b) Identifying local and export market opportunities c) Testing the technical feasibility and development of value added artichoke products d) Assessing the consumer's acceptability of such products. The project aimed also at documenting to the industry the achievable benefits of processing and value adding as a viable and complementary alternative to its present focus on the limited and unpredictable fresh market. The project also touched on the import replacement issue and reviewed the capacity of the artichoke producers in meeting the requirements of a local processing industry. Furthermore, as part of this project, an overseas visit was undertaken by the principal investigator to attend the 4th International Congress on Globe Artichoke in Italy and to review the progress in artichoke processing in two leading countries in this field (see summary report in Appendix 8).

The final outcome of the information gathered will be a re-positioning of the globe artichoke industry to increase production in the face of an anticipated increase in local consumption and export opportunities.

The approach taken in this project for solving the problems associated with a crop such as globe artichoke could be applicable to other marginal vegetable crops. Therefore, it is hoped that this report would be a stepping stone for the initiation of further research projects that address value adding and marketing in other vegetable crops with similar predicaments to globe artichoke.

3.2 Botany and agronomy of globe artichoke

The globe artichoke (*Cynara scolymus*) belongs to the compositae family and is one of the few vegetable crops that can be grown as an annual or as a perennial. It is native to the Mediterranean region, possibly the Middle East, hence the Arabic origin of the name (ardichoki) meaning "earth thorn" (Simpson and Ogorzaly, 1995). The genus *Cynara* comprises seven wild species also native of the Mediterranean basin with the wild cardoon (*Cynara cardunculus*) considered the closest relative and the primary wild gene-pool to the cultivated globe artichoke (Rottenberg and Zohary, 2000). The globe artichoke should not be confused with the Jerusalem artichoke (*Helianthus tuberosus* L.) a plant native to the Americas and related to the sunflower (Schultheis, 1999) or the Chinese artichoke (*Stachys sieboldii* Miq.), both of which are grown for their edible tubers. From its origin as a wild plant, the globe artichoke has developed to become a luxury vegetable as we know it now, cultivated for its edible immature floral bud (head) which is available from late autumn to early spring (Plate 1).

Artichoke is a cross pollinated plant that can be propagated vegetatively as a perennial crop (using stumps and offshoots) or as an annual crop (using seeds). However, in some overseas countries (eg. Italy, France and Egypt) tissue culture is fast becoming an acceptable alternative to the traditional propagation techniques especially for the production of virus free material. Regardless of the propagation technique used, it takes between 5 to 7 months for a plant to produce heads ready for the first cut. Some overseas countries rely on foliar applications of growth hormone sprays (eg. gibberellic acids) to increase earliness and the uniformity of bud development. The plant grows well in a range of soil conditions providing they are fertile and well drained and prefers coastal areas with a mild frost-free climate with temperatures between 15 to 20°C during bud formation in spring. Spacing between rows and plants will determine the size of the heads on the plant and the final number of plants in a field. Ryder et al. (1983) reviewed estimates for plant spacings which optimise total yield/unit area for a number of artichoke producing countries. These estimates varied between countries and ranged from 0.18m²/plant in Egypt to 0.9m²/plant in USA (California). However, the authors maintained that increasing density generally decreased the yield/plant. Normally density would range between 3000 to 6000 plants/ha.

There are a number of world wide artichoke cultivars with considerable morphological variation such as size, bud shape, colour and spininess of the bracts. Many cultivars are synonym, with some in Italy having up to fifteen different names given after the areas where they are grown (Prof. V. Bianco, personal communication). Major research centres for breeding and cultivar selection exist in Italy, Spain and France. A comprehensive collection of over 130 cultivars collected world wide is kept at the Germplasm Institute, Bari University in Italy. Di Venere et al. (2000) found remarkable differences in the biochemical constituents of 35 artichoke cultivars. According to the researchers such useful information could help determining the suitability of various cultivars to specific uses such as fresh, frozen, brined or preserved in oil.

3.3 World production

In 1999 the world's production of artichoke was about 1.2 million tonnes from an area of 119,000 hectares (Anon. 1999a). Nearly 85% of the world's artichokes are grown in countries bordering the Mediterranean basin (Bianco, 2000). Italy and Spain dominate the world production with other countries showing great interest in the crop. In the Northern hemisphere, Egypt is expanding its production ranking fifth in the world and becoming an aggressive exporter to markets in Europe and Northern America. The USA has also been expanding its production steadily with most of it located in the central and southern coastal areas of California. Argentina and Chile are two Southern hemisphere countries showing interest in expanding their artichoke production. Table 1 lists the world top producing countries in 1999 and periods when the crop is available on their local markets. However, the dates listed are only a guide and could differ by a few weeks within the same country depending on the region where artichoke is grown and/or prevailing weather conditions during the growing season.

Table 1. Major World Producers of Globe Artichoke.

Country	Area harvested (ha)	Production (t)	Availability of Crop*
Italy	51,000	472,000	October to March
Spain	18,000	254,000	September to April
France	13,000	73,000	April to November
Argentina	5,000	85,000	June to October
Egypt	3,000	57,000	October to April
USA	5,000	51,000	October to March
Algeria	4,000	30,000	September to March
Morocco	2,000	28,000	September to April
Turkey	2,000	27,000	November to June
Chile	3,000	24,000	June to October
Greece	2,000	23,000	October to May
Tunisia	3,000	25,000	September to April
Peru	Not available	4,000	June to October

Source: FAO Production Yearbook Vol. 53, 1999

* Dates compiled by the authors

** Figures provided have been estimated

Major world producers put great emphasis on maintaining a good stock of cultivars and continuously breeding and selecting hybrids for particular characteristics such as earliness of production, head size, yield and colour. The following are the major cultivars grown in some of the leading producing countries including Argentina, a country considered a competitor to Australia given the similarity of seasons.

Italy: *Romanesco, Violetto di Sicilia, Violetto di Provenza* (known for its earliness and high yield) *Orlando, Spinoso violetto di Palermo, Spinoso Sardo*. Some recently selected cultivars are; *Apollo, Etruso, Moro di Corneto, Branco Star, Pacific, Latino*.

Spain: *Blanca de Tudela* (early producer, represent 90% of the production), *Moretto, Camus de Bretagne*.

France: *Camus de Bretagne, Castel, Violet de Provence, Calico, Salambo, Popvert*.

Argentina: *Nato, Blanc Hyerois, Salanquet, Frances* (represent 90% of artichoke areas), *Oro Verde, Blanco de San Juan, Esmeralda, Camus de Bretagne, Violet of Provenza, Italiano*.

USA: *Imperial Star, Green Globe, Emerald, Grand Beurre, Tolpiot, Purple Sicilian*.

Egypt: *Baladi, Fransawee, Imperial Star, Large Green, Green Globe, Violet, Grand Beurre*.

3.4 The artichoke industry in Australia

Claims are made that artichokes were introduced to Australia by the first fleet in the first year (1788) of European settlement in Australia and that seeds were planted on Norfolk Island (Anon., 2000a).

Italian growers in Victoria around the late 1940's and early 1950's first grew the globe artichoke commercially in Australia. The bulk of the artichoke crop in Australia has been grown close to the shores of Port Phillip Bay at Werribee South in Victoria (Sutherland, 1995). This is because the crop favours coastal climatic conditions. However, varieties are being developed in California for broad climatic adaptability (Anon., 1998a).

Dr.S.C.Tan and Mr H.Hoffmann in Western Australia are also looking into suitable U.S. cultivars for that state (Horticulture Australia Limited, project No.VG97042). In Italy researchers have found remarkable differences in the biochemical constituents between different cultivars (Venere et al., 2000). According to this research this variability could be a useful indicator of the suitability of various cultivars to specific uses (eg. fresh, frozen, preserved in oil etc.). Unlike in overseas countries where a broad gene pool of cultivars exists, in Australia there is a serious shortage of reliable cultivar material. Some of the popular cultivars currently used by many growers, such as Green Globe and Purple Globe are of unknown origin. The majority of growers appreciate the practicality of using seeded cultivars that are currently available. However, few are currently experimenting with such cultivars to test their general performance and reliability.

Various recent publications refer to Australian artichoke production as being steady at 500 tonnes. However, based on the information gathered in our investigation, the artichoke production figure is more like 1300 tonnes (see section 5.1.2). Despite this small production compared to some overseas producers (Table 1), Australia manages to export small volumes of fresh artichokes in an ad-hoc fashion mainly to hospitality trades in the Asia/Pacific region. Trade figures, show that between 1994/95 and 1999/2000, the volume of globe artichokes (fresh or chilled) exports ranged from a low of 2.5 tonnes (\$A5580 per tonne f.o.b.) in 1995/96 to a high of 80 tonnes (\$A3342 per tonne f.o.b.) in 1999/2000 (Anon., 2001a). Statistical Information Service). The statistics also show that Australia's four major exports markets in 1999 were Taiwan, New Caledonia, Singapore and Brunei. Other markets include; Japan, Singapore, China (Hong Kong), Korea, Malaysia and Germany.

3.5 Uses and health benefits

Various parts of the globe artichoke can be used in different ways and for different purposes. The principal edible portion of the immature flower bud we call the artichoke's heart is composed of the fleshy bracts and the receptacle to which the bracts are attached. This part is consumed in a number of ways, such as steamed, boiled, stuffed and then baked, marinated and battered and then fried etc. Another part is the artichoke stalk which when peeled exposes its core, another edible portion of the plant that has a similar texture and flavour to the heart. A favourite Italian way of eating artichoke is "in pinzimonio" which involves dipping the fleshy parts of the bracts one by one into a vinaigrette dressing mixture as above and scrapping it off between the teeth. Besides fresh, various forms of processed artichoke are available on the markets such as preserved whole hearts in brine, frozen and antipasto (appetiser) products, purees (Plate 2).

Globe artichoke is a versatile vegetable, renowned for its nutritional value and excellent health benefits because of its high fibre, vitamin and mineral content, especially iron (Appendix 1). This is in addition to its high content of phytochemical or nutraceutical substances with medicinal functions such as caffeoylquinic acid and cynarin. It is well documented that extracts of globe artichoke leaves are known for their ability to detoxify the liver and stimulate bile secretion (Wegener and Fintelmann, 1999) and to inhibit cholesterol biosynthesis (Gebhardt, 1998). In Argentina, growers can generate additional income from selling artichoke leaves (1.5-3.0 kg per plant at approximately \$A1.00 per kg) to the pharmaceuticals industry (Garcia et al.2000). Cardinali et al., 2000 have shown that the leaves and external bud bracts (which are discarded as waste during processing) represent about 70% of the total biomass and could be utilised to extract important phytochemical compounds. Almela et al., 2000 found that artichoke waste is a valuable material that could be used for animal fodder due to its high total protein content, which is comparable with other

sources of animal feed. Work on animal nutrition in Italy has shown that adding artichoke bracts to lambs' feed led to the lowering of fatty acid components and cholesterol in the meat produced (Marsico et al., 2000).

3.6 Food trends and consumption

Changes in consumers' lifestyles including buying and eating habits are occurring at a fast rate in many developed countries. Australia, according to the vegetable industry strategic plan, has undergone significant demographic changes that have brought a diversity of food which modified consumers behaviour and lifestyle trends (Anon., 1999b). These changes could also be partially attributed to the global economic transformation and the information revolution that is taking place at a fast rate. With the health message becoming widely spread and more noticeable, consumers are turning more to fruit and vegetables and away from meat and dairy products. In the USA, red meat consumption declined 17% over a period of 30 years from 79% in 1970 to 62% in 2000 (Anon., 2001b).

Between 1955 and 1995, the Australian per capita consumption of total fresh vegetable has increased by 39% (from 117 to 163 Kg) (Anon., 1998b). 1997/98 Horticultural Statistics Handbook. Australian Horticultural Corporation, Sydney]. Reports from the USA put the yearly per capita consumption of artichoke at 272g (Anon., 1999c), about ten times that of Australia (28g) (Hoffmann, 2000), whereas in a country like Italy per capita consumption of artichoke is 7kg (Bianco, 2000).

Analysing food trends around the world, Daly et. al. (1997) found that leading vegetable producing countries are increasingly relying on value adding of products. The study also found changes in consumer behaviour which is having an impact on the vegetable sector such as an increasing trend towards convenience foods (eg. supermarkets offering "meals to go" "heat and eat" etc.). While at the moment Australian consumers lack awareness of such meals, there could be a big opportunity for hotels and restaurants (George, 2000). Market research claims that Australian shoppers will be able to order over the fax or phone convenience meals from a new breed of supermarkets (Anon., 1998c). Recent reports indicate that Australians already spend more than \$920 million a year shopping on-line for convenience, a figure that's set to skyrocket in the future (Sloane, 2000). A similar study by Hughson (1997) shows scope for the introduction of new frozen value-added vegetable products. Between 1984 and 1990 sales of frozen meals in Australia grew from \$10 million to \$80 million (Anon., 1995). Australians consume about 500 grams of frozen meals per capita per annum well behind the UK (1000 grams) and the USA (2000 grams). The frozen meals market in Australia has a retail value of \$100 million (Quinton Wilkinson, personal communication).

Changes in food consumption patterns due to changes in lifestyle are also taking place in overseas countries. For example in Japan (a major market for Australian food exports) where demand for fast and convenience foods is increasing. The quantity of frozen vegetables imported over a period of eight years from 1988 and 1996 increased by 90% (from 333,709 tonnes to 633,008 tonnes) (Nguyen, 1998). The import of processed artichokes to the USA increased by 89% from 19,157 tonnes to 36,284 tonnes (Hofmann, 1999-personal communication).

3.7 Anti-browning compounds

The fruit and vegetable processing industry is undergoing constant development in response to the ever increasing demand for high quality convenience products. Processing involves various operations such as cutting, trimming and peeling, all of which induce discolouration

and browning of the tissue (due to various enzymatic and non-enzymatic reactions) which is a major problem that occurs especially during the freezing process. While the enzyme polyphenol oxidase is considered the major one responsible for tissue browning in artichoke, there are indications that other enzyme systems such as peroxidase could also be contributing to the total discolouration in some fruits and vegetables (Vamos-Vigyaso, 1981). It is generally accepted that during artichoke processing the cell damage that occurs leads to dark colouration of the tissue which is due to the reaction of phenolic compounds such as caffeolyquinic acid with ferric iron (Hughes et al., 1962; Mathew and Parpia, 1971). One of the main purposes of this study was to experiment with various anti-browning compounds to find the most effective in controlling browning of artichoke during the freezing process. It is known that anti-browning compounds can be used singularly or in combination for their synergistic effect (Son et al., 2001). A large number of approved food additives have shown various degrees of inhibitory effects such as citric and ascorbic acids on carrambola (Weller et al., 1997), L-cysteine and citric acid in potatoes (Gunes et al., 1997), acetic acid in Lettuce (Tomas-Barberan et al., 1997) and citric acid and ascorbic acid in artichoke (Lattanzio et al., 1989). Another technique used to inhibit enzymatic browning is blanching in plain water heated to various temperatures or water mixed with organic chemicals to enhance the blanching effects. Toivonen (1992), working on enzymatic browning in various parsnips cultivars, concluded that the effectiveness of anti-browning agents is limited by the extent of the injury sustained by the particular cultivar.

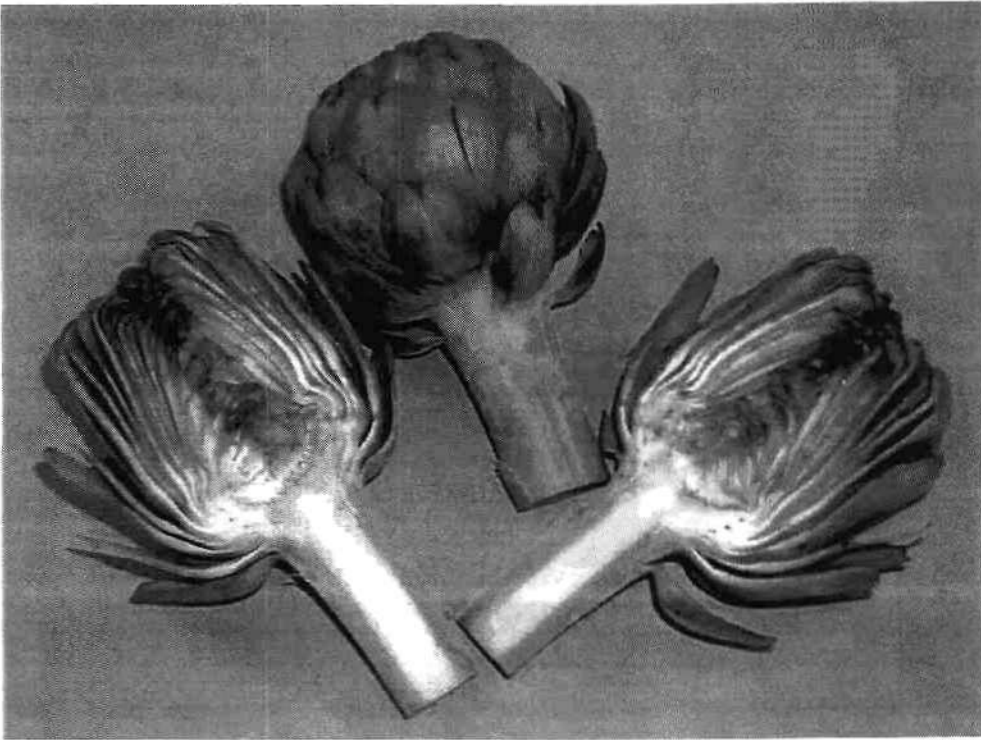


Plate 1. Cross section of a fresh globe artichoke bud



Plate 2. Imported artichoke products available in Australia

4. Research methodology

To meet the objectives of this investigation four different approaches in methodology were taken to:

- 1) Identify and review the general status of the globe artichoke industry in Australia to provide factual information to assist in decision making for the future direction of the industry.
- 2) Experiment with appropriate value adding processing techniques and documenting the achievable benefits to the industry.
- 3) Determine consumers' acceptance of a processed product.
- 4) Demonstrate the economic benefits of value adding to the industry.

4.1 General status of the globe artichoke industry in Australia.

4.1.1 Growers

Detailed statistical information for individual minor crops such as globe artichokes is difficult to retrieve from the Australian Bureau of Statistics as they are generally grouped together under the heading "miscellaneous". Given the small size of the globe artichoke industry, attempts have been made to collect the necessary detailed information pertaining to the industry directly from past and present growers and other industry people. It was felt that the information collected would realistically reflect the actual situation and bring up to date the industry statistics generally referred to. Interviews were held in a series of meetings arranged with twenty growers (past and present) in Victoria the majority of whom were from the Werribee district (where over 80% of the nation's globe artichoke growers exist). Growers were also selected from Keilor, Geelong and the Mornington districts.

Telephone interviews were also conducted with State Vegetable Industry Development Officers and growers in other states. A structured questionnaire (Appendix 2) was used at the interviews to focus the discussion and maintain consistent answers and comment. Questions were structured in a way aimed at obtaining the necessary information (such as; the economics of the crop, acreage, varieties, marketing outlets etc.) that would best describe the status of the industry and reflect the current views and vision of its members. These interviews also helped gain an insight into the industry's problems and aspirations by creating an atmosphere where growers were able to air their views without reservation.

Besides the hand notes taken, answers were also recorded (after permission was obtained from the interviewee) on a hand held tape recorder. Growers were traced in a number of ways; from a recently compiled departmental database on vegetable growers in the Werribee district in Victoria (Anon., 1998d); old departmental records and word of mouth and recommendation from other growers already interviewed. As a matter of courtesy growers were always contacted by phone well in advance and briefed about the project and the purpose of the meeting requested. Following that, a decision was reached about a convenient time and location for the interview session. Practically in all cases the interviews were conducted at the growers' property. However, regardless of where the meetings were held; field, packing shed or even at the kitchen table, it was made sure that the interview was conducted in a relaxed atmosphere, not rigid but flexible enough to allow the interviewees to expand and elaborate in their responses. This allowed in some instances the growers to add extra valuable information that reflected their observations and past experiences. This was particularly true with growers who had left the industry due to either change in directions and/or retirement.

4.1.2 Processors and food services operators

'Kompass' a commercial directory specialising in cataloguing the commercial activities of various Australian businesses lists the following number of establishments that handle processed artichokes: distributors and stockists (43); producers (30); exporters (30) and importers (23) (Anon., 2001c). Specific statistics on imported processed artichokes are difficult to obtain because the Australian Bureau of Statistics (ABS) lists them as "imported mixed processed vegetables", thus making it difficult to separate individual products. Different resource centres contacted (ie. ABS, Australian customs, AQIS, Victoria University of Technology and the Victorian Departmental Agribusiness and Statistics Information Service) also confirmed this. Accordingly, we had to rely on estimated import statistics provided by the relevant industry members such as major processors, importers and distributors who handle imported preserved artichoke hearts.

Interviews were held in a series of meetings with over fifteen food services operators that include processors, restaurateurs/caterers and chefs. The same procedures used with the artichoke growers in regards to contacts and meetings arrangements were followed with the representatives of the food service industry. All industry members interviewed including processors, were from Victoria where more than half the processing establishments in Australia exist.

The purpose of these meetings was two folds: 1) To collect quantitative information on artichokes products currently available in the markets including their source, and the economics of the processed product. 2) To seek the views of the industry on the potential of a processed, frozen artichoke product. Such background information was a necessary step to determine the economics of growing artichokes to satisfy the demand of a local processing industry. In turn, this information can be used to assess opportunities for import replacement.

4.1.3 Consumers

In order to construct a profile of the current domestic consumption of globe artichoke and to identify barriers to further expansion, a comprehensive consumer survey using a structured questionnaire (Appendix 3) was conducted to collect the following information:

- a) consumers' prior knowledge and consumption pattern of globe artichoke and
- b) consumers' views on this vegetable and anticipated consumption rate, including price prepared to pay for a processed artichoke product if available in the market.

In order to avoid any misinterpretation of the questions to be used in the comprehensive survey, a preliminary pilot survey was carried out on a small number ($n = 110$) of randomly selected consumers to ensure the questions were clear.

The major survey consisted of three groups of respondents ($n = 575$) that were interviewed at the following locations; a) The Institute for Horticultural Development (IHD) Open Day ($n = 225$), b) University campuses (Monash and La Trobe) ($n = 157$) and c) Shopping centres (Chadstone and Highpoint) ($n = 193$). Traffic flow in both shopping centres (average number of people visiting the shopping centre per day) supplied by the centres' management is estimated at 240,000 and 280,000 visitors for Chadstone and Highpoint respectively. However, it should be noted that the responses of all people interviewed at these locations are not necessarily a true representation of the total population and therefore may not be a true indicator of the general population.

Samples of fresh globe artichokes harvested shortly prior to the survey were exhibited. The artichokes were not handled or treated in any special way that would affect the consumer's

opinion. In addition to fresh artichokes, samples of frozen artichoke hearts were also exhibited to ensure that the interviewee did not misunderstand the nature of the questions that were asked.

In addition to the consumer survey, our aim was to try and promote knowledge of the globe artichoke at the locations where the surveys were conducted (Plate 3). This was done through the display of informative posters and the distribution of leaflets (eg. preparation steps for cooking fresh artichoke hearts, cooking recipes, nutritional and health benefits etc.).

Simple statistical analyses of the data were carried out to establish a general profile on the consumer's awareness of globe artichoke including current and future consumption trends.

4.2 Evaluation of processing techniques

The purpose of this part of the project was to test different processing techniques to develop two value added products consisting of: a) ready to use frozen artichoke hearts and b) a convenience product consisting of filled frozen artichoke hearts which are ready to 'heat and eat'.

4.2.1 Controlling enzymatic browning

A large number of anti-oxidant compounds were trialed to test their efficacy for controlling enzymatic browning in fresh globe artichokes intended for freezing. This part of the experimental work was a necessary pre-requisite for the selection of the most appropriate treatments that could be developed in the future for commercial application by local industry.

4.2.1.1 Selection of potential anti-browning treatments

Extensive searches of scientific and food technology data bases and websites were undertaken. Literature reporting anti-browning treatments for processing vegetables and fruit were evaluated and if relevant were selected for testing on artichokes. It should be noted that the results of the searches revealed a shortage of published material on the processing of globe artichoke. However, the number of selected treatments, including our added modifications to some of them (such as; varying concentrations of chemicals used, dip duration's etc.) resulted in over 150 formulations/treatments that were systematically tested in a series of exercises. Testing consisted of treating artichoke hearts using standard food technology practices that included blanching in plain water at various temperatures and for different periods of time, dipping in cold or hot water to which various concentrations of one or more approved food additives generally regarded as safe (GRAS) were added. A commercial anti-browning formulation (Snowfresh®) was also included in the tests. Dipping duration was monitored and depending on the treatment used, ranged from 30 seconds to 45 minutes. Selected treatments were tested on samples consisting of 5-8 artichoke hearts depending on their size. Over the life of the project re-testing of certain treatments and the inclusion of new ones was sometimes necessary to clarify previous results and/or eliminate other suspected causes of tissue browning such as varietal differences and tissue maturity.

4.2.1.2 Screening protocol

Given the large number (over 150) of techniques and formulations tested, it was necessary to develop a rapid method for the assessment of their efficacies. This eliminated unsuccessful treatments quickly reducing the number of effective ones to 25 for further refinement and testing (Appendix 4). The following is a description of the general material and methods that were used in all tests in this project.

Source of material: Artichoke heads were sourced from various farms in Werribee, Keilor and Mornington Peninsula, Victoria. In all cases, globe artichokes heads were harvested with about 15cm of stem length a day or two prior to conducting the necessary tests to the Institute for Horticultural Development. In some instances, when the material was to be tested over a period of time (2-3 weeks), the harvested heads were cool stored at 4°C in plastic crates or waxed boxes covered with a PVC film to minimise moisture loss before use.

Cleaning of heads: All anti-oxidant compounds were tested only on the prepared edible portion of the artichoke (ie. the heart). Preparation of the artichoke heads for that included a) trimming the stem part flush with the bottom of the artichoke b) snapping of the green parts of each bract (outer hard leaves that form the head of the artichoke) leaving its white, fleshy base intact and c) scooping out all the choke material) that is at the centre of the artichoke, leaving the heart of the artichoke clean and ready to be treated with one of the anti-oxidant compounds that were tested.

Freezing: Following the treatments with the selected anti-oxidant compounds, the artichoke hearts were then packed in zip sealed plastic bags and stored in a deep freezer kept at -18°C until required for assessment for any discolouration or browning of the tissue.

Assessment of browning: The effectiveness of the various compounds tested in controlling the browning or discolouration of the artichoke hearts had to be assessed in a quick and reliable way. After a period of 3-4 days the frozen artichoke hearts were taken out of the freezer and left for a period of time to thaw at room temperature. During that time the artichoke hearts were observed for any changes in tissue colour and any discolouration that occurred was noted (Plate 4). For each treated sample a subjective rating score of nil, low, medium and high was given for the level and intensity of discolouration by two experienced operators. The key factor that determined the selection of a potential treatment was its sustainable effect in controlling browning for a relatively long period (over four hours).

Other assessments: The effect of tissue age, that is two week old cool stored artichokes, compared with freshly cut heads and its effect on anti-browning treatments was also investigated. The relevance of this exercise, is that the use of stored material for processing is necessary for growers and the processors to even out supply.

In addition, pre-soaking stems of freshly cut artichoke heads in a solution of ascorbic acid (0.05%) for 16 hours, as a preliminary treatment to block the enzymatic activity of the freshly cut tissue prior to processing the hearts with other anti-browning treatments was also tested.

4.3 Consumer acceptance of a processed product

The purpose of this work was to test the feasibility of producing and consumer acceptability of a ready to heat and eat convenience product. This, offers the artichoke industry another opportunity to increase artichoke consumption and subsequently the economic benefits to the industry.

4.3.1 Processing of the product

Three separate recipes were selected and used to stuff artichoke hearts before being baked in an oven. The recipes were based on the use of meat, seafood and vegetables as the principal ingredients. The three types of cooked artichoke hearts were then kept frozen, ready to be subjected to a sensory analysis (after reheating) by independent tasters.

4.3.2 Testing acceptance of processed product

Fifty volunteers from staff members at the Institute for Horticultural Development, Knoxfield took part in the tasting tests. The test was conducted in a properly set-up laboratory (Plate 6) and the samples were presented to the assessors according to the guidelines described by Christie (1966). The volunteer tasters were presented with the three samples of preheated artichoke hearts for evaluation. The order of the evaluation was randomised in accordance with the general test requirements set-up in the Australian Standard for sensory analysis of food (Anon., 1988). Tasters were asked to start by completing a questionnaire (Appendix 5) and then taste the samples and assign their preference ranking on a rating scale that was modified from McBride (1982 and 1985). The scale was used to assist the tasters in assigning their preferences for the following five parameters; appearance, aroma, flavour, texture and an overall quality rating (Appendix 6). The scale consisted of a line 150mm long, with two verbal descriptions representing the minimum (0) "dislike very much" and maximum (150mm) "like very much". The data were obtained by measuring the distance to the response mark assigned by each taster for each variable for each of the three samples. The tests were planned in consultation with the departmental biometrician.



Plate 3. Consumers participating in the survey.



Plate 4. Testing anti-browning compounds on artichoke.



Plate 5. Assessors taking part in taste evaluation.

5. Results and Discussion

5.1 General status of the globe artichoke industry in Australia

The following is a summation of the results of our investigation and the industry's current views on issues seen by its members as being major ones.

5.1.1 Statistics and production practices

Our investigation has produced an updated National database consisting of 36 current and 28 prospective Globe Artichoke growers in all states. The number of active growers in each state is; VIC (20), NSW (4), WA (5), SA (4) and QLD (3). In its present state the artichoke industry consists mainly of traditional family farm units with a limited production destined for the fresh market. The majority of active growers contacted were between 40-55 years old, who have kept the family "tradition" of growing artichokes. In only three cases did we meet younger growers (25-30 years old) interested in either starting to grow the crop or expanding their existing operation.

The sizes of individual properties vary from as little as 0.4 of a hectare (in Manjimup, WA) to between 12 and 15 hectares (in Werribee, Geelong and Keilor, VIC). The average size of most properties is in the order of 1- 3 hectares. However, the number of growers and acreage vary depending on growers entering or exiting the industry due to economic reasons and/or retirement. For example, in the Werribee district, the number of artichoke growers and acreage has been halved since the early 80's (the golden days of the industry according to some growers). During that period, there were over 30 growers with about 400 hectares. At present there are 15 growers with about 180 hectares grown to artichokes. One grower in the district claimed to have produced (over twenty years ago) artichoke from 40 hectares.

The volume of artichoke production in Australia is small by world standards and currently stands, according to our estimate, at 1500 tonnes from an area of about 300 hectares (Table 1, section 3.3). However, the industry through its members has the necessary expertise and capacity to expand and become more dynamic if a better market oriented approach is adopted. Most growers use a perennial type of artichoke vegetatively propagated with replanting taking place every 4-5 years. However, some growers have recently adopted the annual production technique using seeded cultivars that allows them to produce and market their crop earlier than the perennial one. There is a general view among traditional growers that the vegetatively propagated varieties used in the perennial production system are superior and more consistent in yield, size and taste and would be more suitable for processing purposes. We tend to agree with this view based on the material used in our experimentations (ie. larger heads in perennial cultivars than annual ones). However, growers using seeded varieties claim the opposite to be true. In the absence of proper comparative data and the lack of a reasonable number of cultivars, it is difficult to draw a final conclusion on this issue. Our investigation also showed that there is a great deal of confusion and inconsistency in the description of the currently used varietal material. With the exception of some named varieties in use (eg *Global Star* and *Emerald*), the majority of the perennial "varieties" in use are of unknown origin and often referred to by colour (eg. Purple, green and black). It has been reported by other writers (Dodd and Morris, 1996), that planting material is the key to growers' success so it is guarded carefully. A similar situation exists in Italy, where growers give the same cultivar various names derived from the district where it is grown in, thus adding to the confusion (Bianco, pers. Communication). Another view expressed, especially by the younger generation of growers reluctant to enter the artichoke business, is that the crop tie-up a lot land for a long time (especially in the case of perennial crops). Moreover,

according to this group of growers the crop is also time consuming to manage especially at replanting by vegetative means which requires cutting and separating mother plants.

5.1.2 Future vision

Thirty growers have contacted us during the course of this investigation (in response to a media release) expressing interest in growing artichoke as an alternative crop and/or to supplement the existing crops they currently grow. However, the following issues identified by the current artichoke growers express industry concerns about its future and the initiatives needed to address them.

Processing

While the majority of growers are willing to accept the notion of processing, some have reservation that it might affect the fresh market. However, others see room for a supplementary market of premium quality fresh produce and the rest for processing. A couple of growers we have met, claim that there is no cap on the amount of artichoke that can be grown and are willing to expand their operation to accommodate the requirements of any prospective processor if a fixed price contract is in place. This will most likely require a cooperative approach to be taken by growers in a particular district (eg. Werribee) where a number of growers could band together to form an association whose goal is to produce for processing as a first priority. Overseas, growers have adopted a cooperative approach for various reasons. For example, in Texas (USA) spinach growers formed an association to exclusively fund research and promotional efforts to save their industry from declining (Heacox, 2000).

Marketing

Growers were unanimous in admitting that production has been declining steadily following lower demand over recent years. They attribute this to the consumer's ignorance of the crop and its preparation, lack of promotion by supermarkets, insufficient technical handling knowledge of the crop by supermarkets' staff and increasing percentage cost of packaging in relation to the low price returned at the end of the season. Remedies suggested included improve shelf presentation, distribute recipes, highlight the nutritional and health value and improve education for supermarkets' staff in handling the crop. Similar comments were also made by consumers when surveyed.

R&D needed

The growers see that any strategy aimed at improving the viability and sustainability of their industry will have to address a number of issues. These include:

- 1) The need for research on irrigation methods such as trickle irrigation compared to overhead sprinklers. Some growers believe that overhead sprinklers adversely affect the colour and quality of the artichoke heads.
- 2) Developing ways of reducing the costs of production, particularly the labour intensive nature of the crop.
- 3) The need for research in marketing and promotion and assessment of overseas markets potential.

5.2 Status of the artichoke processing industry

Specific statistics on imported processed artichokes are difficult to obtain due to its categorisation by the Australian Bureau of Statistics (ABS) under imported mixed processed vegetables, making it difficult to separate individual products. Other resource centres contacted such as Australian customs, AQIS, Victoria University of Technology and the Agriculture Victoria Agribusiness and Statistics Information Services confirmed this. Accordingly, we had to collect statistical information from other relevant sources within the

industry, namely major processors, importers and distributors of imported preserved artichoke hearts. The data collected from these sources through a series of interviews enabled us to estimate the size and economic activities of the processing industry in Australia.

At present, there is no artichoke processing industry (including freezing) in Australia that relies on fresh artichokes for their operation. According to industry, this is due to the fact that it is labour intensive and there are no machines available in Australia to do the necessary cleaning of the artichoke heads prior to processing.

5.2.1 Size of the industry and processing practices

The information collected suggests there are about twelve establishments in Australia that process artichokes along with other produce such as capsicum, tomato, egg plants and zucchini into antipasto (appetisers) products which are usually sold to delicatessens and the food service industry. About half of these establishments are located in Victoria, two in New South Wales and one in each of the States of Queensland and South Australia. According to one processor, there is no official organisation representing their particular industry and that the prevailing rivalry, secrecy and lack of trust tend to make 'players come and go all the time'. Most processors we have spoken to estimate that between 20 – 25% of the imported artichoke is processed into antipasto product in Victoria. Between them these establishments import up to 750 tonnes of preserved artichokes per annum (worth approximately \$A2.1 million). This includes various types of preserved artichokes (ie. bottled, canned and antipasto).

The bulk of the imported product is used by processors, food service operators and retailers. The volume of the imported material used by each establishment varies throughout the year. In one establishment it varies from one tonne per week to one tonne per month according to demand for processed artichoke products. Practically all the establishments process other products in addition to artichoke hearts such as capsicum, tomato, egg plants and zucchini. Most of these businesses started as a small operation in the last 6-10 years when processed artichokes and other antipasto products became noticed and accepted more by the Australian consumer. This market has expanded due to changes in eating habits, an increase in disposable income, more people eating outside the home and consumers acquiring tastes for the new and exotic products. Most operations are now employing between 10 and 30 staff. Some processors predict that the market trend will continue to improve as consumers become more familiar with the product and its use. At the moment, processed artichoke is ranked third in popularity by one processor after sun dried tomato and egg plants as an antipasto product. The industry mainly supplies the local markets with some exports to the Japanese market. According to some industry members, the demand for processed artichoke products remains strong at 3 million hearts per year and this is expected to double every year into the foreseeable future.

This investigation of the local artichoke processing industry revealed that processors use cheap imported artichoke hearts from Spain, Italy and lately Peru, as their source of "raw" material. Contradictory claims have been made by some processors about the noticeable differences in quality depending on the source of material. Some processors claim that the Spanish artichoke hearts are softer than the Italian ones, which according to them is due to differences in processing techniques or the time it is kept in the can. Others claim that the Italian product is inferior in quality compared to the Spanish one with respect to size, tight shape and genuine count of hearts in the can. Regardless of import sources, the artichoke hearts used by the industry for their processing purposes are usually imported in 3kg cans consisting of 30-40 artichoke hearts (average 35 hearts/can), preserved in brine containing

anti-oxidant agents such as citric and ascorbic acid. The average price per can is \$A9.5 (range of prices according to various estimates varied from \$A7 to \$A12), an increase of over 200% compared to the price of \$A4 per can in 1997/98.

Price changes depend on many factors, mainly the demands of the local industries and the supply of imported artichokes (this in turn could be influenced by weather conditions and other prevailing factors in the countries of origin).

The preserved hearts are re-processed locally into different antipasto products, which sell at delicatessens for about \$A30/kg. The re-processing usually involves the grilling of imported artichoke hearts and the addition of various condiments and oil. According to processors of antipasto products the practice of grilling (charring) the artichokes is used to give the consumers the perception of a homemade product. This reliance of the processing industry on imported material is primarily due to a shortage of supply of locally grown artichokes and the cheaper price of overseas products. However, the re-processing practice currently used prevents the industry from labelling its products as being 100% Australian.

5.2.2 Food Service Operators

According to this industry, artichokes started to appear on menu lists in the early 90's and that consumption will improve as consumers become more familiar with this particular vegetable. At the moment, offering freshly cooked artichoke in season is very limited according to the chefs interviewed. Reasons include the difficulty and time involved in its preparation and the unfamiliarity of some chefs with the vegetable. As a substitute for fresh product, many hotels serve artichokes preserved in brine as an entrée or as part of the main course with meat, poultry and fish. Interviews conducted with chefs, and restaurateurs have revealed that large hospitality establishments rely on processing firms for their supply of fresh vegetables such as straight or mixed vegetables, fresh salads and other speciality vegetables. This practice is usually followed in order to save on labour costs and preparation time. At present, globe artichoke is not one of those vegetables supplied as a processed fresh vegetable to hotels by processors.

Many food service operators, especially large restaurants and catering companies see a definite use for a frozen product. Reasons include time saving factors, convenience of preparation and its availability all year round. However, some chefs expressed willingness to use frozen artichokes not as a main dish but as an accompaniment to other dishes. Chefs like using artichokes because of their novelty factor, that is you don't see them at a lot of restaurants.

Restaurant owners have also experienced more demand for vegetables in lighter vegetarian meals, not because consumers don't eat meat, but because they prefer lighter dishes that are less fattening. The hospitality industry is prepared to pay from \$A0.50 to \$A1.50 per frozen heart, which equates to \$A5.00 to \$A15.00 per packet of 10 frozen artichoke hearts.

5.3 The Consumer

The results reported here represent the consumers' views and opinion on fresh globe artichoke, their frequency of purchase and their acceptance of a frozen product if it was available.

5.3.1 Views and opinions

During the course of the interviews consumers were given the opportunity to make comments on globe artichoke and express their views about reasons for their acceptance and or rejection

of such a vegetable. Commenting on the quality of the fresh artichoke samples exhibited for promotional purpose during the interview, consumers often asked why they cannot find or be supplied with artichokes of the quality exhibited during the survey. Many consumers of the fresh product expressed some dissatisfaction with the artichoke quality available at retail outlets. Consequently there is a considerable challenge for the industry to implement practices to increase consumer's satisfaction with artichoke quality.

Some consumers made the point that if preparation instructions were available at retail outlet, they would be prepared to "experiment" with the product. Others said the availability of information such as recipes and nutritional value leaflets, attractive displays etc. would probably encourage them to buy artichoke. High prices discouraged buyers from buying especially if they didn't know how to prepare them or how they tasted. Some see artichokes as a "special occasion" vegetable. These will be customers aware of artichoke and the difficulty associated with its preparation. Restaurants are places where some customers said they would try things for the first time and if acceptable, would use them at home. A number of responses indicated that canned artichokes are preferred over fresh because of the ease of their use. Consumers of Asian ethnic background are apprehensive about buying fresh globe artichoke. This is because the choke (hairy centre of the artichoke hearts) has been tied up with some anecdotal evidence that it might stick to their throats and cause them to choke. However, practically all respondents in that group claimed to use the boiled water of artichoke for its health value.

5.3.2 Survey results

The difference between survey locations in the responses to some of the questions was statistically significant. This could have been due to differences in age structure and country of birth between the respondents from the three locations. Such significant differences made it inappropriate to analyse the combined number of responses ($n = 575$) as one set of data. Accordingly, it was decided to analyse the survey results as three separate sets of data representing the three types of locations where the survey was conducted. These locations were; the two shopping centres (Chadstone and Highpoint), the two university campuses (Monash and La Trobe) and the Institute for Horticultural Development (IHD) Open Day.

However, for ease of reference we are reporting in Table 2 the combined responses of all people ($n = 575$) surveyed at the three locations.

Table 2. Combined responses (%) of consumers surveyed at three separate locations.

Q1 Do you know what Globe Artichokes are?	
Yes	87%
No	13%
Q2 Where did you first see Globe Artichokes?	
At home / family	35%
Friends	8%
In a restaurant	8%
In a supermarket	23%
On TV	2%
In a magazine / books	5%
Other	7%
Never seen them before	11%
Q3 In what form(s) do you eat Globe Artichokes?	
Fresh (eg. boiled/steamed/roasted)	25%
Processed (eg. bottled/canned/anti-pesto)	19%
Both (fresh and processed)	27%
Never eaten them before	29%
Q4 How often do you eat Globe Artichokes?	
Once per year	17%
2-5 times per year	26%
6-12 times per year	19%
More than 12 times per year	9%
Never eaten them before	29%
Q5 Do you find fresh Globe Artichokes an easy vegetable to prepare?	
Yes	26%
No	19%
Have not prepared them before	55%
Q6 Would you buy a fresh/frozen artichoke if available all year round?	
Yes	22%
No	19%
Maybe	36%
Not applicable	24%
Q7 How much would you pay for such a product? (eg. 10 artichoke hearts)	
\$3-5	36%
\$5-7	20%
\$7-9	1%
Not applicable	43%
Q8 Your gender?	
Male	38%
Female	62%
Q9 Your country of birth?	
Australia	70%
Overseas	30%
Q10 Your age group?	
18-25	27%
26-40	33%
41-60	32%
60+	9%

Table 2, shows that 87% of those surveyed knew what globe artichokes were (Q1) and 70% of that group were Australian born (Q9). The high percentage of respondents knowing about artichokes should not be confused with the level of consumption, which according to the figures is very low. For example the combined figure of those who eat artichoke once a year and those who never eat it (Q4) stands at 46%. There were an almost equal percentage of responses to the various forms of artichoke eaten processed or fresh (Q3). The response to purchasing a frozen product (Q6) indicates a general disposition to buy a convenient frozen product if we take into account the affirmative (22%) and "may be" (36%) responses.

Some statistically significant interactions were noticed between some parameters and the locations where the consumer survey was held. A detailed discussion of the results of these interactions is reported in Appendix 6.

It should be noted that the three sets of responses (corresponding to the three locations) are not necessarily a true representation of the total population and may not be a true indicator of overall opinion or behaviour. However, results of some relevant interactions are reported below.

Shopping Centres respondents:

Gender vs age vs knowledge. This interaction showed that female shoppers are more likely to know what globe artichoke is than male shoppers and that the younger the age of the shoppers the less likely they know about globe artichoke. This suggests that any future promotion campaign aimed at raising the product's profile and sales should target younger shoppers.

Country of birth vs when artichoke was first seen. Shoppers born overseas are more likely to have first seen artichoke at home (34%). For Australian born shoppers, 21% reported that they first saw artichokes at home. For both groups, the supermarket was the second most common place to have first seen artichokes (7% and 12% respectively). The surprisingly large percentage of Australian shoppers who first saw artichokes at home may be due to the influence of overseas born relatives. The information that very few of the respondents first saw artichokes on TV or in a magazine suggests a direction for promotion of the product.

Country of birth vs form eaten. Shoppers born overseas are far more likely to eat artichoke fresh than processed. This suggests that groups of ethnic origin eat them more and perhaps find it easy to prepare or are used to preparing it fresh.

Country of birth vs frequency of eating artichoke. Overseas born shoppers are likely to eat artichokes more often than those respondents born in Australia.

Form eaten vs frequency of eating artichoke. Shopping centre respondents claimed that the more often they ate artichokes, the less likely they were to eat them processed.

Frequency of eating artichoke vs price for a frozen pack. The majority of respondents from the shopping centres thought a price range of \$A3-5 was reasonable for a pack of 10 frozen artichoke hearts-if available on the market. However, those respondents who are frequent eaters of artichokes were prepared to pay a higher price (\$A5-9) for a pack of 10 frozen artichoke hearts. It may be that they appreciate the convenience of such a product and the fact that it will be available to them all year round.

Ease of preparation vs form eaten. Those shoppers who had never prepared artichoke before are more likely to eat them processed.

Ease of preparation vs frequency of eating. The frequent eaters of artichokes find the fresh vegetable easy to prepare.

Ease of preparation vs buying frozen. Those shoppers who had never prepared artichokes were more likely to say that they would buy frozen artichokes if available all year round.

University respondents:

Generally the results were similar to shopping centre surveys with only a few exceptions.

Country of birth vs form eaten. Unlike those at shopping centres, with the respondents at universities, country of birth did not affect the form of artichokes eaten.

Age vs form eaten. The age of university respondents did influence the form of artichokes eaten, whereas age was not important for shoppers.

Country of birth vs frequency of eating. Country of birth did not have a significant effect on the frequency of eating artichokes among university respondents, unlike the results for shoppers.

IHD Open Day respondents:

Form eaten vs frequency of eating. For this group of respondents, the more often they ate artichokes the more likely it was that they ate them processed. This may reflect the dominance of Australian born respondents in this group compared to those interviewed at the shopping centres.

Ease of preparation vs frequency of eating. The frequent eaters of artichokes in this group found the fresh vegetable easy to prepare, yet they were still more likely to eat processed products.

Ease of preparation vs buying frozen. Those respondents who found artichokes easy to prepare were less likely to buy frozen artichokes if available all year round.

Based on the above analysis of the data, it appears that the country of birth is a major indicator of the respondents' familiarity with eating, preparing and buying artichokes. Most people first saw artichokes either at home, with friends or at a restaurant. This could be due to the fact that artichokes are rarely advertised in the media and that 'word of mouth' is currently the way people learn about artichokes.

5.4 Future of processing

This section reports on the results of two types of processing experiments on artichoke hearts. This was necessary because readily available processing information on lines produced by well-known food processing companies is considered a secret of their trade. However, our results showed that controlling the discolouration of processed artichoke hearts intended for freezing is achievable. Furthermore, we were able to further add value to the fresh globe artichoke by being able to produce a product of convenience (ready to heat and eat). The evidence presented in our literature review section clearly indicates that the future in food consumption is heading towards convenience food. With the use of appropriate value adding techniques, the globe artichoke can be transformed into an acceptable convenient product.

5.4.1 Potential anti-browning treatments

Treating artichoke hearts by dipping in cold water containing citric acid or other organic acids can be used to slow down the browning artichoke hearts intended for processing. However, to obtain a sustainable controlling effect for such discolouration heat should be applied to such treatment. Blanching in water heated at different temperatures and containing anti-oxidants (such as organic acids), controlled the discolouration of the artichoke tissue for various length of time. Treatments that showed the best effects in controlling the discolouration caused by the enzymatic activities in globe artichoke hearts during the freezing process are listed in Table 3. The treatments were selected from the original ones listed in Appendix 4 and were sometimes partially modified to suit artichoke hearts. Some of our own treatments are include in the table.

The description of the treatments and their effects on the appearance of the treated artichoke hearts was based on the subjective judgment of two experienced researchers.

Table 3. Selected treatments for their potential to control enzymatic browning.

No.	Treatments	Notes and effects of treatments
1	45min blanch in water (55°C) containing 2% citric acid + 1% ascorbic acid, then cool in iced water for 10min followed by 5min dip in cold water containing 1% citric acid + 4% ascorbic acid + 1% SAPP*	Modified from Reference 10 (Appendix..) By increasing blanching time to 45min. Treated hearts remained creamy white in colour for over 4 hrs after thawing.
2	45min blanch in water (55°C) containing 5% citric acid, then cool in iced water for 10min followed by 5min dip in cold water containing 1% citric acid + 4% ascorbic acid + 1% SAPP.	As above but removed ascorbic acid and increased the concentration of citric acid in the blanching water to 5%. Treated hearts maintained a greenish whitish appearance for about 16 hrs. after thawing.
3	8min blanch in water (80°C) containing 5% citric acid, then cool in iced water for 10min followed by 5min dip in cold water containing 1% citric acid + 4% ascorbic acid + 1% SAPP.	Similar to treatment 2 except that blanching temperature was increased to 80°C and time decreased to 8min. Despite a slight blackening at the base of the outer bracts, the treated hearts remained white inside out for over 3 hrs after thawing.
4	8min blanch in water (80°C) containing 5% citric acid, then cool in iced water for 10min.	Authors treatment. The effects of this treatment falls between treatments 3 and 5. Probably due to the extra treatments missing from 3 (above) and the higher concentration of citric acid used (5%) compared to the 3% used in 5 (below).
5	8min blanch in water (80°C) containing 3% citric acid, then cool in iced water in 10min.	Authors treatment. Treatment caused premature greyish colouration to treated hearts which turned black 3 hrs after thawing.
6	2min blanch in water (70°C) containing 2.5% SAPP followed by 1min dip in hot water (70°C) containing 5% citric acid, then cool in iced water for 10min.	Authors treatment. This treatment caused a slight premature discolouration of treated hearts while undergoing freezing.
7	20min dip in a 5% solution of Snowfresh@**, followed by 6min blanch in water (80°C) containing 5% citric acid, then cool in iced water for 10min.	This modified treatment consists of the recommended Snowfresh treatment (underlined) in addition to the extra treatment mentioned. The general appearance of the hearts treated is acceptable and maintaining a greenish appearance for after thawing.
8	5min blanch in water (80°C) containing 2.5% citric acid, then cool in iced water for 10min followed by a 20min dip in 5% solution of Snowfresh.	In this treatment we have halved the concentration of citric used in treatment 3 (above) and reduced the dipping duration. We also included the recommended Snowfresh treatment (underlined). The effects of this treatment are comparable to treatment 7 (above).
9	5min dip in a cold solution containing 0.03% sodium metabisulphite followed by 10min blanch in water (80°C) containing 5% citric acid, then cool in iced water for 10min.	In this treatment we have used the recipe suggested in Reference 20 (Appendix.), and added the citric acid treatment used in treatment 3 (above). This treatment reduced the artichoke hearts discolouration considerably and the effect was maintained for up to 20hrs after thawing.
10	20min blanch at 70°C in 5% solution of Snowfresh followed by 2min cooling in a solution containing 2.5% citric acid.	This treatment is a modified version of the Snowfresh recommendation. Effects of treatments similar to those described for treatment 7 (above).

* Sodium Acid Pyrophosphate.

** Anti-oxidant compound produced by Monsanto Pty. Ltd.

The effects of the treatments listed in Table 3 indicate that some treatments gave the necessary control of browning in processed artichoke hearts. However, some of these treatments (eg. 1, 2 and 9) gave sustainable effects (ie did not show signs of discolouration) for an acceptable period of time ranging from 4hrs to 20 hrs. Under normal circumstances a frozen product is usually cooked almost immediately and/or straight after it has thawed before the discolouration even become noticeable.

Soaking the stems of freshly cut artichoke heads in a solution of ascorbic acid (0.05%) for 16 hours prior to applying any of the treatments in Table 3 had no added benefits in controlling browning. The idea was to check if soaking in ascorbic acid would help blocking the enzymatic activity in the harvested material until ready to process it. Likewise, applying the selected treatments (Table 3) to two weeks old and freshly cut artichoke heads, had no different effects on the control of browning of the processed hearts. The fact that the age of the material used had no bearing on the effect of the anti-browning treatments used is an important result. The relevance of this result is the practical aspect (for growers and processors) of being able to harvest and store the crop until required for processing without adverse effects.

Along with the best results achieved with the treatments listed in Table 3, we further selected and/or modified 4 more treatments (Table 4) for testing on a commercial scale. The purpose of this exercise was to prove to the industry that any existing establishments that produce frozen vegetables can handle artichoke hearts in the course of their normal operations without great modifications.

A slightly high level of acid after taste was noticed in artichoke hearts that were treated with the high level (5%) of citric acid (Table 3). With the selected treatments in Table 4, we tried to overcome this by using combinations with either no acid added (No.1) or by halving the citric acid levels previously used (No.2).

Table 4. Selected anti-browning treatments tested to simulate commercial scale operations.

No.	Treatments
1	2min blanch in water (97°-100°C) followed by 2min cool in iced water.
2	2min blanch in water (97°-100°C) containing 1.5% citric acid followed by 2min cool in iced water.
3	2min blanch in water (97°-100°C) containing 1% citric acid + 2% ascorbic acid + 1% SAPP followed by 2min cool in iced water.
4	2min blanch in water (97°-100°C) containing 1.5% citric acid followed by 2min cool in iced water containing 1% citric acid + 2% ascorbic acid + 1% SAPP.

5.4.2 Consumers acceptance of a convenience product

The results of consumers responses and opinions on stuffed and frozen artichoke hearts which are ready to "heat and eat" are shown in Table 5. The results show that a high percentage of respondents (72%) have eaten artichoke and that the respondents do not have a special preference for the form of artichoke they eat (fresh, processed or both). However, the fact that a high percentage (72%) of respondents never prepared or cooked artichoke, suggests that this category of consumers are not buyers of fresh artichoke. Furthermore, the fact that 87% of respondents are prepared to buy frozen artichoke hearts ready to cook with a recipe of their choice and that 94% of respondents would buy the ready to "heat and eat" product tends to indicate that consumers are in favour of a product of convenience. Over half of the respondents (54%) are prepared to pay between \$A4 and \$A6 for a pack of 10 plain frozen artichoke hearts and 44% would pay a similar amount for a pack of 4 stuffed artichoke hearts that are ready to "heat and eat". The majority of respondents would buy either forms of the product monthly, if available in the markets.

While the survey was conducted at the Institute for Horticultural Development with staff volunteering to participate, it should not be seen as necessarily representing the total population. Since employees in this situation may be more likely than the rest of the population to try new foods etc given the nature of their work.

Table 5. Responses (%) of consumers acceptance of a convenience product.

Q1	Have you eaten globe artichoke before?	
Yes		72%
No		28%
Q2	In what form(s) have you eaten globe artichoke?	
Prepared fresh and cooked		33%
Processed (eg. Bottled / canned / antipasto)		33%
Both (eg. Fresh and processed)		34%
Q3	Have you ever prepared or cooked fresh globe artichoke before?	
Yes		28%
No		72%
Q4	Did you find it an easy vegetable to prepare?.	
Yes		13%
No		17%
Not applicable		70%
Q5	If frozen artichoke hearts (ie. The edible part of the artichoke) were available on the market all year round	
a)	Would you consider buying it and cooking it with a recipe of your choice?	
Yes		87%
No		13%
b)	How much would you pay for such a product (eg. A pack of 10 unfilled artichoke hearts like the frozen sample)	
\$2-3		17%
\$4-6		54%
Over \$6		9%
Not applicable		20%
c)	How often would you buy it?	
Weekly		2%
Fortnightly		0%
Monthly		39%
Yearly		2%
Occasionally		44%
Not applicable		13%
Q6	If the product (you liked most) was available all year round in a frozen form ready to "heat and eat"	
a)	Would you consider buying it?	
Yes		94%
No		6%
b)	How often would you buy it?	
Weekly		2%
Fortnightly		4%
Monthly		46%
Yearly		0%
Occasionally		41%
Not applicable		7%
c)	How much would you pay for such a product?	
\$2-3		30%
\$4-6		44%
Over \$6		9%
Not applicable		17%
Q7	What do you think of the concept and convenience of a ready to "heat and eat" product like the one you have tasted today?	
Highly acceptable		59%
Acceptable		41%
Not acceptable		0%
Q8	Your gender	
Male		52%
Female		48%
Q9	Your country of birth	
Australia		65%
Overseas		35%
Q10	Your age group?	
20-30		13%
31-40		26%
41-50		41%
50+		20%

Table 6 ranks the responses of the consumers who participated in the tasting survey of three types of cooked, stuffed artichoke hearts prepared with different recipes based on meat, seafood and vegetables. These responses were based on four sensory characteristics in addition to an overall judgment on the product as perceived by the participating assessors. The majority of the responses for all the characteristics were ranked between “like” and “like very much” for the three products. However, for the overall judgment, the meat and seafood recipes were equally either “liked” or “liked very much” by the participating assessors.

Table 6. Results (%) of consumers evaluation of 3 types of cooked artichoke hearts.

MEAT

	Appearance	Aroma	Flavour	Texture	Overall
Dislike	2%	0%	0%	0%	0%
Neither like or not	16%	12%	10%	6%	10%
Like	60%	57%	53%	63%	47%
Like very much	22%	31%	37%	31%	43%

SEAFOOD

	Appearance	Aroma	Flavour	Texture	Overall
Dislike	0%	2%	2%	2%	2%
Neither like or not	18%	27%	8%	4%	8%
Like	54%	45%	53%	61%	47%
Like very much	28%	26%	37%	33%	43%

VEGETABLE

	Appearance	Aroma	Flavour	Texture	Overall
Dislike	2%	2%	6%	2%	4%
Neither like or not	20%	33%	22%	20%	26%
Like	52%	39%	39%	58%	37%
Like very much	26%	26%	33%	20%	33%

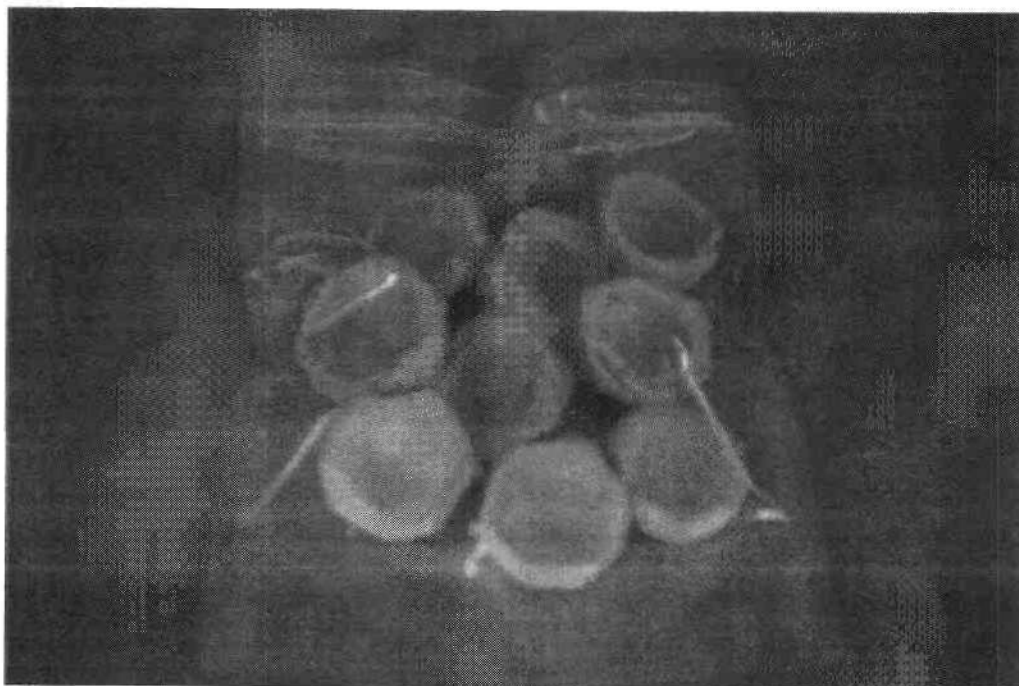


Plate 6. Frozen plain artichoke hearts in a bag presentation

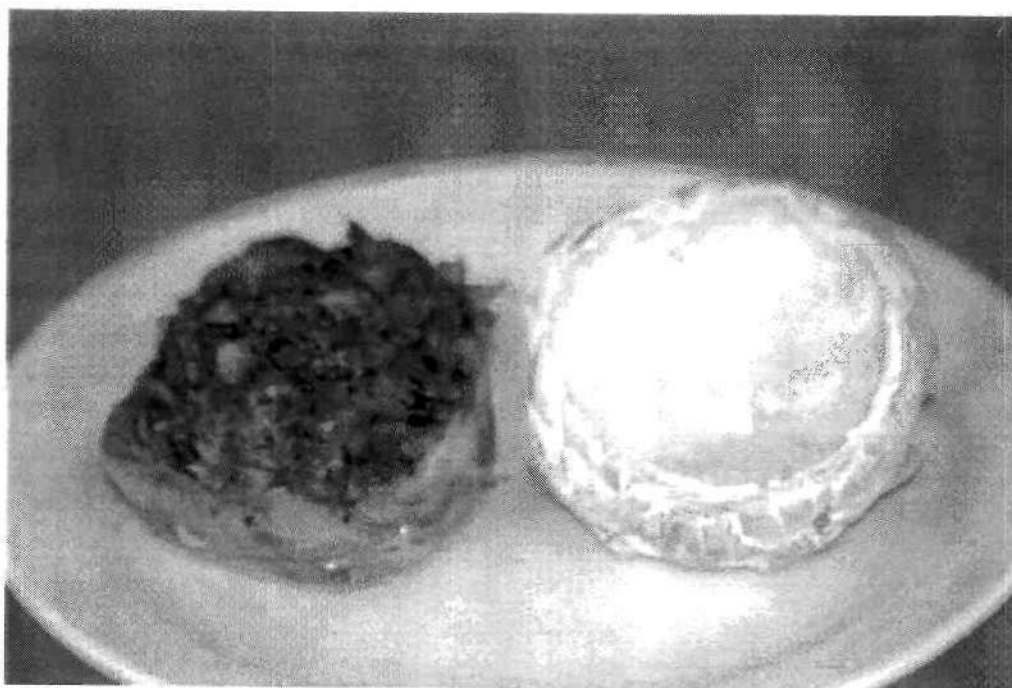


Plate 7. Frozen stuffed artichoke heart ready to “heat and eat” and a plain frozen one

6. Economic consideration and benefits

This investigation has revealed that the Australian production and consumption of artichokes has remained static due to a number of reasons that have been identified and discussed in this report. The almost static artichoke consumption, especially in its fresh form, is causing the industry to worry about its future. However, there are a number of options available to the artichoke growers that can turn their industry around and see it prosper if the proper economic formula is adopted.

The following economic options are windows of opportunities available to the artichoke growers to consider and explore, rather than a detailed cost/benefit analysis, which goes beyond the scope of this investigation.

The assumptions made and the estimates presented here are based on information obtained from the industry, in addition to statistics collected during the course of this investigation. The "for" and "against" arguments for each of the options suggested have been taken in consideration and are also discussed.

6.1 Producing for the local fresh market

Unlike the general per capita increase in consumption of fresh vegetables in Australia, artichoke's consumption has remained consistent and very low by world standard. However, if the industry is to continue producing for the fresh market, it will have to look into some strategies and options that may increase the crop's profile with consumers and therefore its consumption.

One such strategy is to influence the consumer's buying decisions through on-going promotional campaigns focussing on quality, health and nutritional issues. According to Sharp and Morey (1984), the point of purchase is where consumers are most receptive to promotion and information input. However, such a strategy will require a concerted effort from the industry with the cooperation of the retail outlets involved and especially the supermarkets.

Another strategy (Kraus and Brandel, 1988) describes the experience of the Bay Area Restaurants in California in sourcing their fresh speciality vegetables from properties bordering the Bay Area. This was a result of a community movement (People for open space) aimed at preserving the agricultural belt around the bay area. In the process such properties were revitalised and their production increased. For example, Werribee in Victoria offers a similar set up where growers in that district could incorporate restaurants onto their properties and use them as a market niche for their speciality produce. This approach is recognised as an important way of promoting produce in a direct marketing way. (Kraus and Brandel, 1988). Furthermore, the proximity of these properties to the city centre makes it an ideal tourist attraction that could attract (at least in the early stage of the project) some Government assistance for Regional Development.

6.2 Producing for the overseas fresh market

There are a number of European markets that offer an export opportunity for fresh Australian artichokes during their Northern Hemisphere spring/early summer season (March to June). These markets include the United Kingdom, France, Netherlands, Germany and Belgium (Anon., 2000b). In addition to the above markets, the USA also a similar opportunity during the same period. A comprehensive description of some of these export window opportunities available to Australia is reported in HRDC Project VG97402 (Hoffmann, 2000). However, the profitability of exporting fresh artichoke to overseas markets (especially the European ones) should be weighed against the transport costs and the quarantine and trade barriers in existence. Premium prices for artichokes are generally achieved in these markets during their

Northern Hemisphere's winter (November to February) and drop sharply during their spring/early summer (March/June). The export window to Europe falls between June and October, at a time when the Entry Price System (EPS) is not applicable. The EPS is a minimum pricing system applied at certain times of the year to 15 horticultural commodities. If the import price (from non-EU countries) for any of the 15 commodities listed is less than the minimum set by the EU countries, then the importer has to comply with what is known as tariff equivalent (ie. Pay an extra tariff on top the existing standard one) making it less attractive for European importers to import from overseas markets even if their prices are lucrative.

6.3 Producing for processing

We have shown in this investigation that a processed form of artichoke appeals to the consumer due to its convenience either in its plain frozen form or as a ready to "heat and eat" product. It is envisaged that if the industry will embark on producing for processing, it should be aiming at the opportunities available locally as well as those offered in overseas markets. In the following analysis we describe the benefits and the possible hurdles that may be encountered by the industry in its aim to cater for each market.

6.3.1 The local market

On the local scene, two groups are readily identifiable as potential users of artichokes, and these are the local processing industry and the hospitality industry. Both should be targeted by the artichoke industry in any future economic strategy. At present, there is no frozen artichoke processed in Australia. Furthermore, this investigation has shown that in its present state the Australian artichoke industry cannot meet the immediate demand of the local processing industry which relies on imported material for its operation.

6.3.1.1 The processing industry

This industry relies entirely on imported artichoke hearts as their source of "raw" material as mentioned in an earlier section of this report. The processors in the industry estimate they import about 750 tonnes of preserved artichokes at a cost over \$A2 million per annum. According to some members of the processing industry, the demand for processed artichoke products remains strong at 3 million hearts per year and this is expected to double every year into the foreseeable future.

Based on data supplied by growers, the artichoke industry produces in excess of 10 million artichoke heads per year. However, count and diameters' measurements of heads of artichokes left on the plant towards the end of the growing season, revealed that on average about 6 heads/plant fail to size-up. The sizes of such heads range from 50mm to 84mm. The most popular sizes for fresh artichoke heads fall between 88mm and 113mm, however, according to retailers and growers, premium prices are paid for sizes between 100mm and 113mm. Heads that fail to size-up are considered unmarketable as fresh artichokes besides they are not expected to size up to a marketable size around October/November when the ground is being prepared for the new season's crop.

This wasted volume of artichoke hearts represent about one third of the total number of heads plants can produce in a season under Australian conditions. Such a volume can easily be utilised by the local processing industry for their antipasto products and replace the volume of artichokes imported by this industry. Local processors have expressed interest in sourcing their artichokes locally provided they can be guaranteed a continuation of supply at a price comparable to the imported material.

Our investigation showed that consumers are prepared to buy frozen artichoke hearts and that 22% of respondents would buy it if available all year round. Australia's total population as at 2000 was 19,157,000 people (Anon., 2001c), if a modest 5% of the population (957,000 people) would buy one pack of 10 frozen artichokes hearts per year, this would translate into a consumption level close to 10 million hearts per year. If this were to occur, the artichoke industry would have to double its production from its present level.

6.3.1.2 The hospitality industry

Our discussion with people in this industry sector revealed an obvious general agreement that a processed artichoke (frozen) would facilitate the tasks of chefs and other caterers in preparing and offering meals based on artichokes. This will be largely due to the convenience of such a product and its availability during the whole year.

In Australia at the end of June 1999, there were 25,966 establishments representing restaurants/cafes (12,845) and take away food (13,121) (Anon., 2000c).

With the above information, we can project a consumption level of about 13.5 million hearts per year based on 5% of these establishments (1298 establishments) serving two artichokes heart per 100 patrons weekly. A similar situation could be expected in the catering industry.

When all of the above scenarios presented are taken into consideration by the artichoke industry it equates to a projected overall consumption of over 26 million artichoke hearts that would more than double the existing level of globe artichoke production. This should be seen by the artichoke growers as an encouraging sign to consider production for a local processing market. However, some problems that will need to be addressed by the artichoke industry include suitability of currently used cultivars for processing, economics of scale, labour costs and management skills necessary for addressing future grower/processor relationships. Growers should aim at working cooperatively to develop a properly managed direct supply chain and gradually delist middlemen such as agents and wholesalers. Furthermore, increasing the production levels will be a necessary step to meet the processing industry needs. This could be achieved with the development of larger farm units instead of the fragmented family farm operations currently in operation. Victoria, with its concentration of artichoke producers around the Werribee district is ideally situated for that purpose. The presence of a local processing industry in such a district would provide a necessary element for the integration of both industries. Such arrangements could also be economically beneficial for regional development.

6.3.2 Export markets

In addition to the local markets, the artichoke industry must identify potential overseas markets such as some Asian markets where rapid increase in the standard of living has occurred. The increase in standard of living in countries such as; Indonesia and Malaysia was followed by an increase in demand for more convenient processed products (Hickey, 1995).

Japan is the number one market for Australian food exports, in 2000 the total Australian food exports to Japan amounted to \$4.2 billion. Australia's market share of foodstuff in Japan during 2000 amounted to 6.6%, compared to the US with 30.1% (Wing, 2001). The quantity of frozen vegetables imported to Japan over a period of eight years from 1988 to 1996 increased by 90%, from 333,709 tonnes to 633,008 tonnes (Nguyen, 1998).

A report on the opportunities and consumers requirements in key Asian vegetable markets indicates that a great opportunity exists in the Japanese market for semi-processed and frozen vegetables which are demanded by the processing and retail sectors. This opportunity needs to be investigated as preliminary work done in this project suggests there may be a market for processed, frozen artichoke products in Japan (Anon., 2001d). Potentially this market is substantially larger than that available in Australia. Furthermore, there is none or little information available with respect to the potential for frozen artichoke export to other overseas markets.

7. Recommendations

The local globe artichoke industry possesses the necessary expertise and reasonably modern modes of production to enable substantial expansion of the industry. Through its evaluation of the local production scene, this investigation has been able to identify several existing problems and propose promising short and long term solutions that are available to the industry. Such solutions, if properly adopted by the industry, would increase the profile of its product locally and capture a share of overseas markets. The following are some of our recommendations in this regard.

In the short to medium term globe artichoke producers will need to re-vitalise the local fresh market which will remain relatively small but has the potential to expand. This will require:

- a) The introduction of appealing and consistent quality cultivars to ensure consumer satisfaction and repeat purchase.
- b) The involvement in and adoption of promotional activities to build up the industry's profile and that of the fresh crop. This will include developing a good working relationship with supermarkets to train staff on how to handle the produce, to develop attractive point of sale material such as recipes.

At the present time there is a certain lack of vision in the artichoke industry with respect to investigating and adopting new processing techniques for fresh product and remains untapped by local growers and processing firms. This study recommends that for the long term growth of the artichoke industry, the fresh market will have to be supplemented by a viable processing sector that could rely for its supply on a strong and reliable local production. Processing could start by targeting local and exploring overseas niche markets. As the demand for fresh and processed products increases growers will be able to make informed decisions as to whether to produce for processing, fresh or both markets.

Given the small and fragmented nature of the globe artichoke industry in Australia, individual growers do not have the necessary production capacity or marketing solidarity to develop a viable industry. Therefore, industry members interested in processing will need to coordinate their efforts in terms of production and marketing and if necessary take a cooperative approach.

Furthermore, the industry needs to be attuned with the current overseas views and future trends of their industry at an international level. Such views were expressed at the recently held Fourth International Artichoke Congress (Italy) and include:

- More research needed to improve propagating material.
- Selection of seed propagated cultivars that mature during autumn.
- Characterise cultivars according to suitability for consumption and end use such as fresh or processing.
- Better understanding of the role of growth regulators in production.
- More work in postharvest physiology to increase storage life.
- Better understanding of enzymatic activities and utilisation of by-products and identify the potential for phytopharmaceuticals.
- More research in food technology to develop ready to use and minimally processed products.

8. Technology Transfer

The Australian globe artichoke industry, ancillary industries (Food service etc.) and Horticulture Australia Limited (HAL) were kept abreast of the developments and progress made during the course of this investigation in the form of written progress reports and meetings. Furthermore, the vegetable industry development officers in all states growing artichoke were briefed about the project since its initiation and kept informed about its development. However, due to the commercial sensitivity of the results, especially those associated with the processing aspect of the investigation, little detail has been published and public disclosure will be kept to a minimum until the final report is cleared by HAL.

During the course of the investigation the following extension activities have been conducted:

Industry contacts and briefings.

Australian Restaurant and Catering Association contacted.
Twenty food processors briefed and invited to express views on project.
State vegetable IDO's contacted and summary of project brief forwarded for publication.
Further contacts were maintained to keep IDO's abreast with progress made.
Contacted wholesale market officials (eg. Sue Dodd, Sydney market; Noel Harvey, Qld. Fruit and Vegetable Manager; Lisa-Huong Nguyen, SA-Virginia Hort. Centre).
Communication established with members of the food and hospitality service (Chefs/Restaurant manager's etc.).

Publications.

Newsletter produced and distributed quarterly to 40 growers and processors.
State wide media releases sent and published in written media such as Shepparton News, Country News and Southern Farmer.
Article published in VegeLink newsletter.
Article published in Proceedings of Fourth International Artichoke Congress (Bari-Italy).
Article printed in "Good Fruit and Vegetables".
Two articles printed (artichoke recipes and summary of consumer research) in WA Vegelink (insert in WA Grower) in December 2000.
Article prepared for media release "Frozen artichokes - a cool alternative" to promote a processed artichoke and to entice potential investors to express their interest in commercialising the technique.
Submission of abstract for a poster presentation on processed artichokes at the forthcoming Australian Postharvest Conference (23-28 September, 2001) in Adelaide.
Article on the convenience of a processed artichoke product printed in the new VegCheque newsletter (Vegetable Matters).

Growers meetings.

Meeting and briefing Agmark's chairman, growers, distributor and marketing agent.
Two meetings with Werribee's young vegetable growers.

Field Days and Promotional activities.

Presentation and circulation of handout at monthly meeting of Werribee Grower Group.
Promotion of artichoke project in a display at the IHD open days (Oct. 6-7) for both industry and the public.
Poster presentation at the Horticulture in NRE conference at the Institute for Horticulture Development (Sept. 6-7).

Poster presentation at the Gympie (Qld.) VGA field day (Nov. 15).
Artichoke poster displayed at the Werribee Expo on 3 and 4 May, 2001.
Promotional posters were also displayed at The Horticulture Conference held at the Department of Natural Resource and Environment (Knoxfield).

International Exhibitions and Conferences.

Poster presentation at the IV International Artichoke Congress (Bari- Italy).
Translation of poster from English to Japanese on 2 stands to promote Australian artichokes at the 10th International Food Fair (Oct. 5-9) held at Kitakyushu (Japan). A local TV crew filmed the poster.
Liasing with artichoke growers, agribusiness section and Australian export company to set up a live exhibit of Australian artichoke at the above event.
Export of a sample of frozen artichoke hearts to Japan for comments by the Head Chef of a large Italian restaurant chain and to explore the acceptability of the product in that market.

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11. Appendices

Appendix 1. Nutritional value of raw globe artichoke per 100g edible portion

Water	85.2g
Energy	80 kJ (19 kcal)
Fat	0.2g
Protein	2.8 g
Carbohydrate	1.3 g
Sugars	0.9 g
Starch	0.4 g
Dietary fibre	0.8 g
Cholesterol	Nil
Sodium	6 mg
Potassium	360 mg
Calcium	30 mg
Magnesium	18 mg
Iron	0.5 mg
Zinc	0.6 mg
Retinol equiv.	15 µg
β-Carotene equiv.	90 µg
Thiamin	0.06 mg
Riboflavin	0.08 mg
Niacin	0.6 mg
Vitamin C	16 mg

Source: English, R. and Waters, J.(1992). Nutritional values of Australian Foods, Department of Community Services and Health, Australian Government Publishing Service, Canberra. 62pp.

Appendix 2. Questionnaire used for interviewing growers.

1. Contact details (Optional):

Name
 Business
 Address
 Suburb/State/Post code
 Phone Number
 Fax
 E-mail

2. Are you an artichoke grower? Yes / No (circle)
 (a) If yes, how long have you been growing artichokes? (years)
 Go to question 3.
 (b) If no, would you be interested in growing artichokes in the future? Yes / No / Maybe (circle)
 Go to question 25 (page 3).
3. In what year did you first grow artichokes? 19.....
4. What size area are your artichokes? (acres or hectares) (circle)
5. What artichoke variety(s) do you or have you grown?
6. In your opinion which variety is the best and why?
7. Do you grow artichokes from seed, seedlings or vegetatively? (circle)
 Why?
8. What is your artichoke planting season? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec (circle)
9. What is your artichoke harvesting season? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec (circle)
10. What is the lifecycle of an artichoke (from planting to harvest)? (weeks)
11. How old are the seedlings when first planted? (weeks)
12. What is the shelf life of an artichoke and the optimal temperature to handle/store it?
 (days/°C)
13. Over time, has your acreage increased, decreased or remained static? (circle)
 Why?
14. What is your yield per acre or hectare? (tonnes or cartons)
15. Has your yield increased or decreased over time or remained constant? (circle)
 Why?
16. What is the average cost of production? \$...../acre or hectare (circle)
17. What is the average return? \$...../acre or hectare (circle)
18. Does the price of artichokes fluctuate during the season? Yes / No (circle)

Why?

19. Who do you sell your crop to? Wholesaler / Retailer / Distributor / Other (circle)
20. What is the destination of your crop? Local / Interstate / Overseas (Export) / Other (circle)
21. What are your current practices for growing, harvesting and storing artichokes?
.....
22. Have you had any bad experiences with producing or marketing artichokes? Yes / No (circle)
eg. growing, harvesting, storing, transporting (ie. efforts in establishing a crop Vs return or seasonality).
Explain
23. Any success stories? Yes / No (circle)
Explain
24. In your opinion, has consumption increased or decreased? (circle)
(a) Since which year? 19..... Why?
(b) If decreasing, how can the trend be reversed, the image enhanced or the market expanded?
.....
25. Do you know of any other growers (past, present or potential) that could be contacted or would be interested in being involved? Yes / No
Details
26. What do you see or others see as the main barriers/concerns with the artichoke industry at present?
.....
27. What could be done to promote the crop and how could it be done?
28. Who are the main users/consumers of Artichokes? (eg. specific ethnic groups - old/young, restaurants, catering firms etc)
29. What R&D is being done or needs to be done to increase yields? (eg. new varieties, better management practices etc)
30. Who do you turn to, for technical information or advice?
31. Do you see a need for an industry body? Yes /No (circle)
(a) If yes, how would you like to see it set up or run?
33. How can IHD/NRE best help you?
34. Other comments, questions or suggestions?

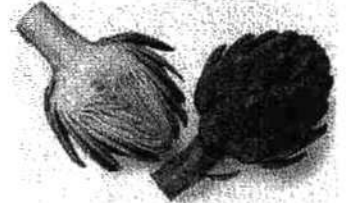
Appendix 3. Consumers' questionnaire used in surveys.

Artichoke Survey

Your contribution will help artichoke growers better understand consumer's requirements and assist them in future planning.

Two reasons for the survey:

- (1) to understand your knowledge of Globe artichokes
- (2) to hear your opinion about a fresh/frozen artichoke.



Please tick the most appropriate answer for each of the following questions:

1. Do you know what Globe Artichokes are?

- Yes
- No

2. Where did you first see Globe Artichokes?

- At home / family
- Friends
- In a restaurant
- In a supermarket
- On TV
- In a magazine / books
- Other
- Never seen them before

3. In what form(s) do you eat Globe Artichokes?

- Fresh (eg. Boiled/steamed/roasted)
- Processed (eg. bottled/canned/anti-pesto)
- Both (fresh and processed)
- Never eaten them before

4. How often do you eat Globe Artichokes?

- Once per year
- 2-5 times per year
- 6-12 times per year
- More than 12 times per year
- Never eaten them before

5. Do you find fresh Globe Artichokes an easy vegetable to prepare?

- Yes
- No
- Have not prepared them before

6. Would you buy a fresh/frozen artichoke if available all year round?

- Yes
- No
- Maybe
- Not applicable



7. How much would you pay for such a product? (eg. 10 artichoke hearts)

- \$3-5
- \$5-7
- \$7-9
- Not applicable

8. Your gender?

- Male
- Female

9. Your country of birth?

- Australia
- Overseas

10. Your age group?

- 18-25
- 26-40
- 41-60
- Over 60

Any comments?



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Appendix 4. Anti-browning treatments proven efficacious in controlling discolouration in various fruits and vegetables selected for testing on artichokes.

No.	AUTHOR	SOURCE	TREATMENTS USED	EXPRIMENTAL MATERIAL
1	Beck-RG (1992)	Basic American Foods, San Fransisco, CA, USA	Sodium acid pyrophosphate (SAPP), Cysteine, Calcium chloride	Fruit & vegetables
2	Gunes, -G; Splittstoesser, -DF; Lee, -CY (1997)	J-food-prot. Des Moines July 1997	L- Cysteine, Citric acid mixture	Potatoes
3	Weller, -A.; Sims, -C.A.; Matthews, -R.F.; Bates, -R.P.; Brecht, -J.K (1997)	J - food - sci - Chicago (Mar/April 1997)	1% or 2.5% citric acid + 0.25% ascorbic acid	Carambola
4	Jiang, Y.M.; Fu, -J.R.; Zauberman, -G.; Fuchs, Y. (1999)	J-sci-food -agric. (May 1999)	L-Cysteine and citric acid	Litchi fruit
5	Gunes, -G.; Lee, -C.Y. (1997)	J. food sci.Chicago (May/June 1997)	L-Cysteine (0.5%) and citric acid (2%) mixture + Nitrogen flushing inside the bag before storage	Potatoes
6	Robert, -C.; Richard-Forget, F.; Rouch, -C.; Pabion, -M; Cadet, -F. (1998)	Int. -J. -bichem -cell-biol. Oxford, UK (April 1996)	L- Cysteine, Cysteine	Fruits and vegetables
7	Friedman, -M.; Bautista, -F.F (1995)	J.agric-food-chem. Washington, D.C (Jan 1995)	L-Cysteine (as alternatives to sodium bisulphite)	Fruits and vegetables
8	Bacetti - LB; Falcone -M (1995)	Revista-do-instituto - Adolfo-lutz; 1995	Citric acid, Sodium metabisulphite or mixture of both to prevent browning	Banana
9	Lourenco-EJ; Neves-VA; Silva-Mada (1992)	Ciencia-e- Tecnologia- de-Alimentos (1992)	L-Cysteine, ascorbic acid, citric acid	Palm
10	Sapers, -G.M.; Miller, -R.L.(1995)	J-food-sci. Chicago. (July / Aug.) 1995	Heated 1% ascorbic acid + 2% citric acid (5-20 min) at 45°-55° cooled, and then dipped for 5' in browning inhibitor solution containing 4% ascorbic acid + 1% citric acid + 1% SAPP	Potatoes
11	Mencarelli-F; Massantini-R; Casella-M (1993)	Journal of Horticultural Science. 1993	Effects of calcium chloride, citric acid and ascorbic acid on a quality of globe artichokes	Artichoke
12	Lattanzio-V; Linsalata-V; Palmieri-S; Sumere-CF-van (1989)	Food Chemistry 1989	% solutions of citric acid or ascorbic acid before storage	Artichokes
13	Masterocola, -D.; Pittia, -P; Lerici, -C.R. (1996)	J- food - qual Trumbull, Conn. Food & Nutrition Press (April 1996)	Blanching in anti-oxidant agents (ascorbic and citric acids) Light dip in cold water after treatment	Apples
14	Pizzocaro, -F.; Torreggiani, -D.; Gilardi, -G (1993)	J-food- process-preserv. Food & Nutrition Press 1993	Mixtures of ascorbic acid and citric acid or ascorbic acid and sodium chloride	Apples
15	Langdon, -T.T. (1987)	Food-Technol. Chicago, May 1987	potassium sorbate, citric acid, and ascorbic acid	Potatoes
16	Lee-JinCheol; Eun-JongBeng; Lee-JC; Eun-JB; Lee-JungMyung (ed.); Gross-KC (ed.); Watada-AE (ed.); Lee SeungKoo (1999)	Acta- Horticulturae 1999	3% ascorbic acid, erythorbic acid or citric acid or 0.5% acetic acid single or mixed	Lotus

17	Tomas-Barberan,-F.A.; Gil,-M.I.; Castaner,-M.; Artes, -F.; Saltveit,-M.E.(1997)	J-agric-food chem. Washington, D.C.:American Chemical Society. (Mar 1997)	Acetic acid	Lettuce
18	Castaner-M; Gil-ML; Artes-F (1997)	Zeitschrift-fur-Lebensmittel-Untersuchung-und-Forschung. 1997	Acetic, propionic, oxalic and lactic acid	Baby lettuce and endive
19	Castaner-M; Gil-ML; Artes-F; Tomas-Barberan-FA. (1996)	Journal-of-Food-Science 1996	Organic acid (citric, acetic) vinegar and lemon juice	Lettuce
20	Mohamed-S; Othman-E; Abdullah-F. (1988)	Pertanika. 1988	sodium metabisulphite, calcium chloride + metabisulphite or calcium chloride + ascorbic acid	Rambutans
21	Nogueira,-JN; Silva,-E (1989)	Anais-da-Escola-Superior-de- Agricultura -'Luiz-de-Queiroz' 1989	Treated for 2 minutes at 70, 80 or 90°C or with SO ₂ (0.05-0.2%) or ascorbic acid (0.1-1.0%)	Banana, Peaches, Apples, Carrots, Cauliflowers and Palmito)
22	Brecht-JK; Sabaa-Srur-Auo; Sargent-SA; Bender-RJ. (1993)	Acta-Horticulturae. 1993	Sodium and calcium hypochlorite,.	Cut vegetables and fruits
23	Anon (1997)	Michigan state University Extension. Preserving Food Safety-01600655	Blanching for 7 minutes	Globe artichoke
24	Mader, Sharon L . (1997)	The Ohio State University Extension. Fact sheet	Blanching for 7 minutes	Globe artichoke

Appendix 5 Consumer acceptance of a processed product:
Please tick [] the most appropriate answer for each question.

- Q1 Have you eaten Globe Artichoke before today?
 Yes No
- Q2 In what form(s) did you eat Globe Artichoke?
 Fresh (eg. boiled/steamed/stuffed)
 Processed (eg. bottled/canned/antipasto)
 Both (eg. fresh and processed)
 Never eaten before
- Q3 Have you ever prepared or cooked fresh Globe Artichoke before?
 Yes No
- Q4 Did you find it an easy vegetable to prepare?
 Yes No Never prepared
- Q5 If fresh/frozen artichoke hearts (ie. the edible part of the artichoke) were available on the market all year round (see frozen sample in front of you) would you:
- a) Consider buying it and cooking it with a recipe of your choice?
 Yes No
- b) How much would you pay for such a product (eg. a pack of 10 unfilled artichoke hearts)? \$.....
- c) How often would you buy it?
 Weekly Fortnightly Monthly N/A

Taste test

Q6 Please refer to instruction marked "Q6" in front of you.

- Q7 If the product (you liked most) was available all year round in a frozen form ready to "heat and eat" would you:
- a) Consider buying it?
 Yes No
- b) How often would you buy it?
 Weekly Fortnightly Monthly N/A
- c) How much would you pay for such a product (eg. a pack of 4 filled artichoke hearts)? \$.....
- Q8 From your point of view, what do you think of the concept and convenience of a ready to "heat and eat" product like have tasted today?
 Highly acceptable Acceptable Not acceptable
- Q9 Your gender?
 Male Female
- Q10 Your country of birth?
 Australia Overseas
- Q11 Your age group? (optional)
 20-30 31-40 41-50 50+

Thank you for your time and cooperation
Fouad and Glenn ☺

Appendix 6. Rating scale for measurement of preference for three types of cooked artichoke Hearts.

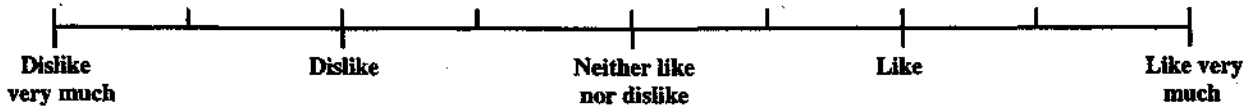
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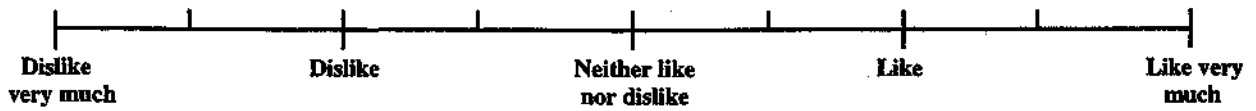
AROMA:



FLAVOUR:



TEXTURE:



OVERALL:



Appendix 7. Results of some significant statistical interactions between some parameters and surveys' locations.

Analysis of the Artichoke Survey (Interactions).

The surveys were carried out in 3 different locations: IHD Open Day (n=225), University campuses (n=157) and Shopping Centres (n=193).

A1 Is there a difference between location in the responses to Q1, Q8 and Q9 ?

The difference between locations was found to be statistically significant ($p < 0.001$) and it appeared that those respondents from the IHD Open Day were less likely to know what an artichoke was.(Q1)

The difference in the gender (Q8) breakdown between locations was not statistically significant.

However, the difference in the proportion of respondents born in Australia as compared to those born overseas (Q9) was significantly different between locations ($p < 0.001$). For the two shopping centres (Chadstone and Highpoint), the proportion of respondents born overseas was approximately half of the respondents, whilst at the two universities and the IHD Open Day, the proportion of those born overseas was much less than half.

The difference in the age structure (Q10) of the respondents was significantly different between locations ($p < 0.001$) with the two universities having a larger proportion of respondents in the youngest age group.

Due to these differences between the respondents from each location, it was decided to analyse the surveys as three sets of data. These were The Shops (consisting of Chadstone and Highpoint), The Unis (consisting of Monash and LaTrobe) and IHD Open Day.

A2 Do gender (Q8), country of birth (Q9) or age (Q10) affect whether the respondent knew what an artichoke was (Q1) ?

	Shops	Unis	IHD Open Day
Q1 v Q8	P=0.047	P = 0.021	P=0.827
Q1 v Q9	P=0.177	P = 0.622	P = 0.319
Q1 v Q10	P = 0.014	P = 0.251	P < 0.001

For shoppers, country of birth did not seem to relate to whether the respondent knew what an artichoke was. However, gender and the age of the respondent did seem to affect whether the respondent knew what an artichoke was or not.

For the universities, only gender appeared to affect whether a respondent knew what an artichoke was or not.

For IHD Open Day respondents, only the age of the respondent appeared to affect the answer to Q1.

We continued the analysis of the data using only those respondents who answered that they knew what an artichoke was.

A3 Do gender (Q8), country of birth (Q9) or age (Q10) affect where the respondent first saw an artichoke (Q2).

(Due to the small number of respondents who chose TV, magazines or books or "other" as their answer to Q2, we combined these categories)

	Shops	Unis	IHD Open Day
Q2 v Q8	P = 0.484	P = 0.873	P = 0.619
Q2 v Q9	P < 0.001	P = 0.090	P = 0.905
Q2 v Q10	P = 0.616	P = 0.370	P = 0.357

For the shoppers, the country of birth clearly affected where the respondent first saw the artichoke. If born overseas, they were more likely to have seen them at home/with family and less likely to have first seen them with friends or in the media.

A4 Do gender (Q8), country of birth (Q9) or age (Q10) affect the form that we eat artichokes in. (Q3)?

	Shops	unis	IHD Open Day
Q3 v Q8	P = 0.555	P = 0.863	P = 0.347
Q3 v Q9	P < 0.001	P = 0.830	P = 0.401
Q3 v Q10	P = 0.431	P = 0.096	P = 0.501

Amongst shoppers, the country of birth affected the form of eating artichokes with those born overseas far more likely to eat them fresh.

A5 Is there a relationship between the form the respondent eats the artichokes in (Q30 and how often the respondents eat artichokes Q4)?

	Shops	unis	IHD Open Day
Q3 v Q4	P = 0.057	P = 0.231	P = 0.005

For both the shoppers and the IHD Open Day respondents, there was clearly a relationship between these two questions. For the shoppers, the more often they ate artichokes, the less likely they were to eat them processed. However, for the IHD Open Day respondents, the more often they ate them the more likely it were that they ate them processed. This can be actually due to the difference between the locations in the country of birth of the respondents.

A6 Do gender (Q8), country of birth (Q9) or age (Q10) affect how often we eat artichokes (Q4)?

	Shops	unis	IHD Open Day
Q4 v Q8	0.513	0.794	0.739
Q4 v Q9	0.006	0.674	0.924
Q4 v Q10	0.408	0.283	0.488

Only for the shoppers and only for the country of birth was the effect significant. Those shoppers born overseas were likely to eat artichokes more often than those respondents born in Australia.

A7 Is there a relationship between Q4 and Q7? Is there a relationship between how often the respondents ate artichokes and the price they were prepared to pay? Note that only the top two price points were tested as too few respondents chose the dearest price point.

	Shop	unis	IHD Open Day
Q4 v Q7	P = 0.068	P = 0.241	P = 0.597

For shoppers, there appeared to be a relationship...for the smaller numbers who were prepared to pay the higher price for artichokes, they were also eating them more often.

A8 Is there a relationship between Q5 (whether artichokes are easy to prepare or not) and the other questions relating to the eating of artichokes (Q3, Q4 and Q6)? Respondents were dropped who answered 'not applicable' to Q6 or 'never eaten them before' for Q3 or Q4.

	shoppers	unis	IHD Open Day
Q5 v Q3	P < 0.001	P < 0.001	P < 0.001
Q5 v Q4	P = 0.005	P = 0.016	P = 0.029
Q5 v Q6	P = 0.011	P = 0.573	P < 0.001

For all three groups, there was a significant relationship between Q5 and both Q3 and Q4.

For Q3, the relationship was the same, ie that those who had never prepared artichokes before were much more likely to eat them processed.

For Q4, The more often the respondents ate artichokes, the more likely they were to say that artichokes were easy to prepare.

The relationship between Q 5 and Q6 was significant for the shoppers and IHD Open Day. For shoppers, those who had never prepared artichokes were more likely to say that they would buy fresh/frozen artichokes if available all year round. For the IHD Open Day respondents, those who answered that they found artichokes easy to prepare, were less likely to buy fresh/frozen artichokes if available all year round.

Based on this simple analysis of the data, it appears that the country of birth is a major indicator of the respondents' familiarity with eating, preparation and buying of artichokes.

Most people first saw artichokes either at home, with friends or at a restaurant. I suspect that this is due to the fact that artichokes are rarely advertised in the media and that 'word of mouth' is currently the way people learn about artichokes.

I suspect that Q3 was a little ambiguous. I suggest that the question could be interpreted in two different ways: (a) In what form are Globe artichokes eaten? (ie they don't ever have to have eaten artichokes to answer this interpretation of the question) or (b) in what form do they (ie the respondent) eat artichokes?

BACKGROUND:

Mr Goubran undertook an overseas visit to:

- 1) Attend and present a paper at the 4th International Congress on Globe Artichoke in Italy and
- 2) Visit research establishments and processing factories in France and Egypt, two countries where globe artichoke is a well-established industry.

The visit was an integral part of the project "The globe artichoke : A strategy to stimulate local consumption, export and import replacement. VG99030", funded by Horticulture Australia Ltd. (formerly Horticultural Research and Development Corporation). The project aim is to increase local market acceptance and export opportunities for globe artichoke through value-adding.

In 1999 nearly 85% of world artichoke (118,723ha) was grown in countries bordering the Mediterranean basin with Italy, Spain and France accounting for about 70% of the crop production. By contrast globe artichoke production in Australia (90% of which emanates from Victoria) has remained steady at about 500 tonnes compared to other vegetables. This lack of growth is attributed to the unfamiliarity of local consumers with the vegetable and its use, and/or difficulty in its preparation for use. It is estimated that in excess of \$1.5M of frozen and canned artichoke are imported into Australia yearly. Furthermore, industry is showing a certain lack of vision by not addressing export opportunities and the economic consequences of adopting new processing techniques, at the moment untapped by growers and processing firms.

This visit offered Mr Goubran a unique opportunity to interact with about 100 artichoke specialists from over 16 countries who were attending the congress (last congress was held 21 years ago) and familiarise himself with many advancements in the artichoke industry world wide and particularly in the countries he visited. The information gathered will be extended help the Australian artichoke industry keep abreast of the latest development in their industry world-wide particularly in the fields of value-adding and marketing techniques. This in turn will help our local artichoke industry re-positioning itself to meet an expected increase in both export and local consumption of artichoke.

PURPOSE OF VISIT:

During this visit Mr Goubran's duties were to address the following objectives:

1. To attend the 4th International Congress on Globe Artichoke held in Italy (17-21 Oct.) and present a paper on the status of the artichoke industry in Australia.
2. Visit THE International Food Exhibition known as "Salon International de L'Alimentation (SIAL) held in Paris (22-26 Oct.) to familiarise myself with the latest development in food technology and value-adding taking place in the 90 countries that were represented.
3. Review with researchers at key research centres in France and Egypt problems associated with production methods and to identify potential cultivars suitable for Australian conditions.
4. Familiarise himself with artichoke processing techniques used in the countries visited and evaluate their relevance and possible adoption by the Australian industry to enable it to compete successfully in niche markets.

5. Build contacts with overseas researchers and establishments with the view of exchanging information and more importantly to introduce new artichoke cultivars to enrich the gene pool in Australia.

OUTCOME OF VISIT:

Overall the visit highlighted the following issues:

- While Australia's globe artichoke industry is a small one by world standard it does however use modes of production and crop management comparable with big producing countries. In addition the industry possess the necessary expertise which would enable it to expand if required with minimum extra inputs and/or changes to current practices.
- Various papers presented at the Congress (in Italy) by keynote speakers confirmed that many artichoke growing countries overseas face similar issues to Australia. However, some of the novelty works that were presented could open up new horizons for our industry if adopted such as: performance of different cvs. in off-season production; the use of artichoke leaves for herbal drug production and the effects of growth regulators on earliness of production. While Italy is the largest artichoke producer in the world (43% of world production) it is also a big consumer of the product leaving the export scene wide open to Spain (nearly 50% of world export). Germany is by far the largest importing country (30,000t fresh and 11,000t processed).
- In all countries visited breeding and variety selection is of paramount importance especially in France where work is being carried out at the Centre for Plant Breeding and Biotechnology (Bretagne Biotechnologie Vegetale (BBV) and at the Institut National de la Recherche Agronomique (INRA) for the improvement of seed lines and selection for suitable processing characteristics and maturity timing (to coincide with particular export windows). Similar interest and work is being done at the Egyptian Agricultural Research Centre (In Giza) under their program Agricultural Transfer and Utilization Technology (ATUT). In the Bretagne Region (NW of France) where the largest artichoke growing areas exist, the scene is dominated by the presence of a large processing plant, trading under the brand name of "Prince de Bretagne".
- In addition to satisfying the domestic markets, Egypt's artichoke production is also export oriented. European markets such as; Germany, France and others offer convenient export windows from October to December for Egyptian producers – while this export window coincides with the main Australian season, market analysis by WA Department of Agriculture indicates there are still opportunities for Australian producers in some European markets at that time - . Furthermore, artichoke processing is playing an important part on the Egyptian export scene and the processing industry is dominated by 2-3 large corporations. Big corporations have the advantage of affording investment in equipment and coordinating the sourcing activities of raw material.
- Processing plants in countries visited rely on a range of other vegetables besides artichoke for their processing operation. This is important to overcome seasonality factors and ensure the economical usage of their machinery.
- During the course of the trip undertaken, links were established with a number of researchers in relevant fields with the view of exchanging information and especially the importation to Australia of much needed new cultivars. As a result arrangements were

made with Mr. Jean Corre an artichoke breeding expert with INRA for the importation of a number of artichoke varieties to Australia. This was seen as a necessary step required to enrich the local gene pool and allowing for the selection of suitable material for processing.

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