

**Managing micro-organism loading in
Pistachio nuts to ensure the product is
Food Safe while maintaining integrity.**

Trevor Ranford
Pistachio Growers of Australia

Project Number: PS10000

PS10000

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the pistachio industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of Pistachio Growers of Australia.

All expressions of opinion are not to be regarded as expressing the opinion of Horticulture Australia Ltd or any authority of the Australian Government.

The Company and the Australian Government accept no responsibility for any of the opinions or the accuracy of the information contained in this report and readers should rely upon their own enquiries in making decisions concerning their own interests.

ISBN 0 7341 3007 4

Published and distributed by:
Horticulture Australia Ltd
Level 7
179 Elizabeth Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399

© Copyright 2012



Horticulture Australia

**FINAL REPORT.
(Public Copy)**

PROJECT NO: PS10000

PROJECT TITLE: Managing microorganism loading in Pistachio nuts to ensure the product is Food Safe while maintaining integrity.

**AUTHORS: Trevor Ranford
Executive Officer
Pistachio Growers' Association Inc
and
Grant Birrell
Chief Executive Officer
Australian Pioneer Pistachio Company**

**RESEARCH PROVIDER: Pistachio Growers Association Inc
27 Ludgate Hill Road
ALDGATE. SA. 5154.**

PROJECT NO: PS10000

PROJECT LEADER: Mr Trevor Ranford
Executive Officer
Pistachio Growers Association Inc
27 Ludgate Hill Road
ALDGATE, SA. 5154
Phone: 08 83394826
Mobile: 0417 809 172
Email: sahort@bigpond.com

And

Grant Birrell
Chief Executive Officer
Australian Pioneer Pistachio Company

PURPOSE OF PROJECT: The project undertook trials to investigate the high microorganism loading in Pistachio nuts following the 2011 harvest and to establish a methodology to overcome this contamination without compromising the organoleptic properties of the nuts, so enabling the 2011 crop to become suitable for sale.

FUNDING SOURCES: This project was funded by Horticulture Australia Limited using a voluntary contribution from the Pistachio Growers Association Inc and matched funds from the Australian Government.

DATE OF REPORT: 28th August 2012

DISCLAIMER:

“Any recommendations contained in this publication do not necessarily represent current HAL policy. No person should act on the basis of the contents of this publication, whether as to matters of fact or opinion or other content, without first obtaining specific, independent professional advice in respect of the matters set out in this publication.”

Table of Contents

1. MEDIA SUMMARY	4
2. TECHNICAL SUMMARY	5
3. INTRODUCTION	7
4. MATERIAL & METHODS	8
5. RESULTS.....	9
a. Research Work 9	
i. Identify microorganism types.....	9
ii. Identify extent of spore forming organisms' composition.....	9
iii. Conduct laboratory scale investigations to establish microorganism kill rate profiles for a range of dry heat temperatures and time periods.	9
iv. Conduct laboratory scale investigations to establish microorganism kill rate profiles for a range of applications targeting spore formers using steam rehydration followed by dry heat.	10
v. Evaluate the changes to the organoleptic properties of the processed nuts at the optimal bacterial kill method.....	10
vi. Evaluate optimal process methods over a range of microorganism loads.	10
vii. Establish levels of confidence to reduce pathogenic bacteria to acceptable levels.....	10
viii. Establish scale up methodology to replicate optimal processes at the Robinvale Pistachio factory.....	10
b. Efficacy of the Proposed Treatments 11	
6. DISCUSSION AND CONCLUSIONS	12
7. TECHNOLOGY TRANSFER.....	12
8. RECOMMENDATIONS	12
9. ACKNOWLEDGMENTS.....	13

1. MEDIA SUMMARY

The 2010/11 Pistachio crop was contaminated with a fungal disease, Anthracnose, prior to harvest. The disease had never been recorded as affecting Pistachios and the knowledge of industry was limited. The consequence of the disease was that the crop yield was reduced by at least 50% and the physical appearance and taste of the harvested nuts had been substantially compromised. Most of the nuts were of an inferior quality and not suitable for retail sale.

Pistachio nuts are sold raw or as a roasted and salted product. While there was a quality issue with the 2011 harvest season nuts, it was believed the problems could be overcome in the roasting and salting process. Roasting and salting involves the nuts being dipped into a brine solution for one minute followed by roasting in an oven roaster at 105 °C for around 60 minutes.

Unfortunately, this treatment was not effective in achieving the desired result. After consultation with experts in Australia and pistachio experts in the USA, the problem with the product was identified.

This project addressed these particular issues with the objective of making the product food safe with minimal effect on the overall quality of the product.

After extensive testing and trial work, a technique was developed and utilised during 2012. This technique has resulted in nearly the entire 2011 crop being treated and sold to the market.

The project has delivered an extremely successful outcome: Australian Pioneer Pistachio Company (APPC) was able to take non saleable nuts and through the process developed through this project to produce safe food of an acceptable quality.

If it were not for this project the value of the crop, estimated at around \$5,000,000, would have been lost.

The good result of this project will enable adverse quality product to be treated in a similar way in the future.

2. TECHNICAL SUMMARY

The 2010/11 Pistachio crop was contaminated with a fungal disease, Anthracnose, prior to harvest. The disease had never been recorded as affecting Pistachios and the knowledge of industry was limited. The consequence of the disease was that the crop yield was reduced by at least 50% and the physical appearance and taste of the harvested crop had been substantially compromised. Most importantly, there were excessively high microorganism levels in the dried product.

Pistachio nuts are sold raw or as a roasted and salted product. Microorganism contamination in Australian pistachios had not been experienced in any of the prior 20 seasons. When microorganism problems became evident with the hulled and dried product following the 2011 harvest season, it was believed the problems could be overcome in the roasting and salting process. Roasting and salting involves the nuts being dipped into a brine solution for one minute followed by roasting in an oven roaster at 105 C for around 60 minutes. By any measure this process would be considered a sufficient “kill” step to reduce the microorganism levels to nil or acceptable levels. With the 2011 crop this treatment was not effective in achieving the desired result. After consultation with microbiological experts in Australia and pistachio experts in the USA, the problem with the product was identified as:

- Anthracnose caused hull breakdown to the extent that many other organisms from environmental sources were able to fester onto the product
- The product had a significantly higher microorganism loading this season,
- The microorganisms were able to ingress deep inside the nut shell making it more difficult to treat the product
- Rodents, particularly mice, were much more prevalent this season and may have passed on some contamination either prior to or during harvest.

Therefore, whilst it was reasonable to assume the roasting and salting process would control the microorganism levels, the “normal” treatment was not effective under these circumstances.

This project addressed these particular issues with the objective of making the product food safe with minimal effect on the organoleptic (taste, odour, etc) quality of the product.

The initial processes centred on identifying the temperature treatment required to reduce the Total Plate Count (TPC) to acceptable levels. TPC can be reduced by a treatment of ‘short time at high temperature’ or ‘long time at low temperature’.

Through the trial work the project team was able to determine the time-temperature relationship required to lower the TPC. Trials were also able to determine the required time-treatment process to reduce a known TPC to the numbers required to meet the specification set, thereby giving the nuts a minimum heat treatment to achieve the required results.

Through steaming trials it was revealed that the product was less affected by steam than roasting whilst being virtually 100% effective as a “kill” step. It also reduced some of the off flavours originating within the nuts

Substantial testing was conducted using the final steaming method developed. This demonstrated that steaming at a set temperature for an appropriate time reduced the bacterial load to virtually nil at all times.

The project has delivered an extremely successful outcome: Australian Pioneer Pistachio Company (APPC) was able to take non saleable nuts through the process developed by this project and produce safe food of an acceptable quality.

3. INTRODUCTION

The 2010/11 Pistachio crop was contaminated with a fungal disease, Anthracnose, prior to harvest. The disease has never been recorded as affecting Pistachios and the knowledge of industry was limited. The consequence of the disease was that the crop yield was reduced by at least 50% and the physical appearance and taste had been substantially compromised. Most importantly, there were excessively high microorganism levels in the dried product.

Microorganism contamination in Australian pistachios had not been experienced in any of the prior 20 seasons. When microorganism contamination became evident with the hulled and dried product following the 2011 harvest season, it was believed the problem could be overcome in the roasting and salting process.

Pistachio nuts are sold raw or as a roasted and salted product. Roasting and salting involves the nuts being dipped into a brine solution for one minute followed by roasting in an oven roaster at 105 °C for around 60 minutes. This process would normally be considered a sufficient “kill” step to reduce the microorganism levels to nil or acceptable levels.

This treatment was not effective in achieving the desired result with the 2011 crop. After consultation with microbiological experts in Australia and pistachio experts in the USA, the problem with the product was identified as;

- Anthracnose caused hull breakdown to the extent that many other organisms from environmental sources were able to fester onto the product
- The product had a significantly higher microorganism loading this season,
- The microorganisms were able to ingress deep inside the nut shell making it more difficult to treat the product
- Rodents, particularly mice, were much more prevalent this season and may have passed on some contamination either prior to harvest or postharvest

Therefore, whilst it was reasonable to assume the roasting and salting process would control the microorganism levels, the “normal” treatment was not effective this time.

Information gathered from researchers including Dr Prue McMichael from Scholefield Robinson Horticultural Services Pty Ltd and international pistachio processors indicated that this was a unique set of circumstances that had not been recorded anywhere else.

This project addressed these particular issues with the objective of making the product food safe with minimal effect on the overall quality of the product.

4. MATERIAL & METHODS

The following components were part of the project:-

a) Identify microorganism types.

Standard plating techniques were utilised by the microbiologists to establish total plate counts with the aim of identifying each microorganism to genus level.

b) Identify extent of spore forming organisms' composition.

From the identification of the bacteria, the microbiologists established which were sporing microorganisms and which were non-sporing.

c) Conduct laboratory scale investigations to establish microorganism kill rate profiles for a range of dry heat temperatures and time periods.

d) Conduct laboratory scale investigations to establish microorganism kill rate profiles for a range of applications targeting spore formers using steam rehydration followed by dry heat.

e) Evaluate the changes to the organoleptic properties of the processed nuts at the optimal bacterial kill method.

Utilising taste panels and nut appearance each treatment was assessed to understand whether there were any changes to the organoleptic properties of the nuts.

f) Evaluate optimal process methods over a range of microorganism loads.

Each different treatment was assessed against both the level of microorganism contamination and the organoleptic properties to obtain one or more treatments that achieved the food safety requirements yet retained product integrity.

g) Establish levels of confidence to reduce pathogenic bacteria to acceptable levels

h) Establish scale up methodology to replicate optimal processes at the Robinvale Pistachio factory.

5. RESULTS

a. Research Work

i. Identify microorganism types.

Dr Chris Murray, a Microbiologist with 40 years experience was consulted regarding identification of the microorganisms concerned. He advised that testing for total plate count, E coli, Salmonella and yeasts and moulds would provide sufficient understanding of the microorganisms concerned.

ii. Identify extent of spore forming organisms' composition.

Through the work of Dr Chris Murray, the project team was able to establish methods which reduced the total plate count and the yeast and moulds, both of which measure spore forming and non spore forming bacteria, which resulted in sufficient control.

Various product origins were tested to establish the extent of microorganism contamination within the entire crop and from that the team was able to determine the range and extent of the problem throughout the crop.

iii. Conduct laboratory scale investigations to establish microorganism kill rate profiles for a range of dry heat temperatures and time periods.

The initial processes centred on finding the temperature treatments required to reduce the Total Plate Count (TPC) to acceptable levels. TPC can typically be reduced by 'short time at high temperature' or 'long time at low temperature' regimes. There was concern that too high a temperature would destroy the nuts.

The following trials were conducted:-

- Roasting and salting at various temperatures and roast times
- High concentration salt wash followed by roasting
- Chlorine wash followed by roasting
- Ozone treatment
- Perfume treatment
- Methyl Bromide treatment
- Extended drying treatment
- Time and temperature heat trials conducted by Bottrill Research
- Germination trials conducted by Bottirll Research
- Steaming trials

Through the trial work the project team was able to determine the time-temperature relationship required to lower the TPC. Trials were also able to determine the required time-treatment process to reduce a known TPC to the

numbers required to meet the specification set, thereby giving the nuts a minimum heat treatment to achieve the required results.

iv. Conduct laboratory scale investigations to establish microorganism kill rate profiles for a range of applications targeting spore formers using steam rehydration followed by dry heat.

Bacteria can exist as vegetative organisms that are very susceptible to heat and easily killed, or as a range of dormant forms ranging in heat resistance. Spores of *Bacillus* species are very resistant to heat, particularly if it is dry heat.

To establish the best treatment the following trials were conducted:-

- Time and temperature trials conducted by Bottrill Research
- Germination trials conducted by Bottrill Research
- Steaming trials using a pilot steamer.

v. Evaluate the changes to the organoleptic properties of the processed nuts at the optimal bacterial kill method.

Organoleptic testing identified that

- excessive roasting over-roasted the product and therefore created an upper limit of roasting that could be applied to “kill” the organisms
- steam treating the product revealed that the product was less affected by steaming whilst being virtually 100% effective as a “kill” step. As an added advantage, steam treating reduced some of the off flavours originating within the nuts

vi. Evaluate optimal process methods over a range of microorganism loads.

Substantial testing was conducted using the steaming method to validate that steaming at a set temperature for an appropriate time reduced the bacterial load to virtually nil at all times.

vii. Establish levels of confidence to reduce pathogenic bacteria to acceptable levels

The results from the steaming trials proved the process with a high degree of confidence.

viii. Establish scale up methodology to replicate optimal processes at the Robinvale Pistachio factory.

A high capacity steaming system was sourced and installed to replicate the laboratory trials and has been used successfully in production since.

Following the steaming process the product was then dried back to less than 7% moisture using existing plenum driers. The method devised was able to process around 8 metric tonnes (8,000 kg) per day which met the product capacity requirements once underway.

One unexpected benefit of the steaming process was the dilution effect the steam had on the odd off flavoured pistachio. The steaming seemed to improve the consistency of flavour with the pistachios, removing the effects of these off flavoured nuts.

b. Efficacy of the Proposed Treatments

The process was approved by the South Australian Department for Health and Ageing and the Victorian Department of Health as an effective control measure for salmonella contamination.

Substantial test results have proved the method with minimal adverse response from the marketplace.

6. DISCUSSION AND CONCLUSIONS

After extensive testing and trial work the technique developed and utilised during 2012 has resulted in the 2011 crop being treated by the methodology devised and nearly all the product has been sold to the market.

The outcome of the project was extremely successful and APPC was able to take non saleable nuts and through the process developed by this project to produce safe food of an acceptable quality.

If it were not for this project the value of the crop, estimated at around \$5,000,000, would have been lost.

From a technology transfer point of view, the good result of this project will enable adverse quality product to be treated in a similar way in the future.

7. TECHNOLOGY TRANSFER

This project has now established a methodology for treating in-shell pistachio nuts affected by excess microorganism contamination. This will provide the ability to deal with adverse seasonal conditions in the future.

The PGAI intends to retain confidentially of this system for a period of two years.

8. RECOMMENDATIONS

The following recommendations are made by the project team:-

- 1) That the new treatment technique be used on future adverse quality nuts and the results validated to ensure that the technique continues to be successful.
- 2) That where necessary the treatment technique be modified based on sound science and testing results.
- 3) That the information about the new treatment technique be made available to other Australian pistachio processors in a confidential manner to ensure that any adverse quality products are not placed into the retail market and create a potential crisis management situation for the Australian Pistachio Industry.
- 4) That at the completion of the confidentiality period the treatment technique be written up and made available to other processors of pistachios and processors of other nuts.

9. ACKNOWLEDGMENTS

The authors would like to acknowledge the

- Financial support of Horticulture Australia Limited and The Pistachio Growers' Association Inc,
- Field and laboratory work support from Australian Pioneer Pistachio Company,
- Dean Bottrill from Bottrill Research Pty Ltd, and
- Brian Thorn and Chris Murray