CENTRE FOR FOOD TECHNOLOGY

REPORT ON SHELF LIFE OF PICKLED OCTOPUS, BBQ MARINATED OCTOPUS, AND CHILLED VACUUM PACKED OCTOPUS

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ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

A shelf life of 5 days, 2 months and 4 months respectively for the chilled vacuum packed octopus, chilled BBQ octopus and pickled octopus is recommended from the results of the storage trial. These shelf life recommendations are based upon microbiological counts for the chilled vacuum packed octopus and chilled BBQ octopus and sensory evaluations for the pickled octopus.

Extending the shelf life may be possible for the chilled vacuum packed octopus with a change in the packaging type. Extending the shelf life should be possible for the chilled BBQ octopus by reformulation of the sauce to lower the pH below 4.0 and/or some alterations to the processing method.

No recommendations are given to improve the sensory perceptions of the pickled octopus.

It is strongly recommended that the manufacturer of such products adopts a quality assurance system, document critical control points and keep written records of each batch processed.

INTRODUCTION

Funds were allocated by the National Seafood Centre (NSC) for shelf life trials on Pickled octopus, BBQ marinated octopus and chilled vacuum packed octopus. The Product Development Group at the Centre For Food Technology, DPI, Hamilton, Queensland conducted the trials.

Objectives

1. To evaluate the current processing methods as supplied by the manufacturer.

2. To evaluate the shelf life of the following products.

> Pickled octopus over 6 months storage.
> BBQ marinated octopus over 3 months.
> Chilled vacuumed packed octopus over 21 days.

Storage conditions

Samples will be stored at 4°C and 10°C. The evaluation at 10°C is included to simulate the temperature above which the product may be subjected to during distribution, (abuse temperature) and to test the shelf life expected at this storage temperature.

Duration of Storage Trial

1. Pickled octopus stored for 6 months or to the end of the shelf life if the quality becomes unacceptable before this point.

2. BBQ marinated octopus stored for 3 months or to the end of the shelf life if the quality becomes unacceptable before this point.

3. Chilled vacuum packed octopus stored for 21 days or to the end of the shelf life if the quality becomes unacceptable before this point.

Results

Chemical and microbial analyses results for vacuum packed octopus, BBQ octopus, and pickled octopus (see Appendix 1A, 1B and 1C respectively).

Sensory assessment for the vacuum packed octopus, BBQ octopus and pickled octopus (see Appendix 2A, 2B and 2C respectively).

Process flow charts for the vacuum packed octopus, BBQ octopus and pickled octopus (see Appendix 3A, 3B and 3C respectively).

DISCUSSION AND CONCLUSION

SHELF LIFE EVALUATIONS

Chilled Vacuum Packed Octopus

Analytical Results

The microbiological results indicated substantial growth within 7 days at storage temperatures of 4°C and 10°C. Testing was terminated at day 14.

Sensory Results

The vacuum was lost within 3 days of manufacture. The product had noticeably deteriorated by day 7 moving from a strong oily fish smell to distinctively putrid by day 9 at 10°C and day 14 at 4°C. Colour changed from an off white/cream to a dark tan. A noticeable bacterial slime was present at days 9 and 14 for 10°C and 4°C respectively.

Evaluation

A shelf life of 5 to 7 days should be possible when stored under refrigeration (0^0 to 4°C). Storage temperature above 4°C will dramatically reduce the shelf life.

Product quality could be improved by selecting appropriate packaging for vacuum packing. The product assessed was packed in thick plastic bags which are difficult to seal and generally have high O_2/moisture permeability. Barrier bags with low moisture/oxygen permeability and designed for vacuum packaging are recommended. Seals should also be checked for leaks. Appropriate packaging film selection will reduce the proportion of leaking bags.

BBQ Octopus

Analytical Results

The microbiological results indicated substantial growth within 2 months at storage temperatures of 4°C and 10°C. Testing was terminated at the required 3 months.

The pH ranged from 4.6 to 5.0, and water activity (Aw) was 0.96. This means the pH and Aw are too high to significantly prevent microbial growth. The salt and titratible acidity results indicated levels too low to help preserve the product.

Sensory Results

The grey colour of the cut flesh changed to light brown over the 3-month period as the sauce penetrated into the flesh.

The texture and flavour both showed slight changes. After 2 months at 4°C and 10°C the flavour lost much of the spiciness and the texture of the flesh became firmer

The odour did not change over the period of the storage trial.

Evaluation

A maximum of 2 months shelf life at 4°C is recommended based on the samples evaluated. A reduction of the pH and or a change in processing may help extend the shelf life.

The oil ingredient becomes immiscible on the surface of the product within a few days of manufacture. Reformulation to maintain oil in suspension within the sauce may improve the appearance and help reduce potential anaerobic conditions. If the formulation of the sauce remains unchanged, a statement on the label suggesting shaking prior to opening to mix the oil and sauce should be considered.

Pickled Octopus

Analytical Results

The microbiological results show that there was no growth of bacteria, yeasts or moulds over the duration of the storage trial. There was little change in the water activity (Aw) or acidity and pH ranged from 4.1 to 4.5.

Sensory

Almost immediately the peppercorns and mustard seeds settled and oil was immiscible on the surface. The pickle became cloudy within 21 days at 10°C and 57 days at 4°C.

The skin on the tentacles went from red/light brown to a bleached tan colour by day 64 and commenced falling off the flesh by day 107. Penetration of the pickle was visible by a colour change from white to off white / cream. The off white / cream colouration slowly penetrated the muscle stabilising by day 84 at 10°C and day 107 at 4°C.

The odour changed from a fresh vigorous acidic smell with a spicy residual aroma to a dull pickled odour by day 84 at 10°C and 107 at 4°C. This was consistent with a loss of the sharp crisp acidic flavour becoming dry and vinegary with a total loss of any fresh aftertaste.

Texture also changed from firm/moist to rubbery loosing the moist mouth feel experienced in the early stages of the shelf life.

Evaluation

A shelf life between 3 and 4 months is recommended based upon sensory evaluation. By month 4 (107 days) a noticeable difference was perceived between fresh product and the trial product. Although the octopus was edible the pickle had become bland and the flesh rubbery. This may result in negative customer feedback. The microbiological results indicated no growth.

Processing Evaluation

The processing methods supplied by the manufacturer have been transcribed into process flow charts (Appendix 3). A questionnaire was also completed (see Appendix 4) to determine the level of quality assurance employed. It is assumed that Good Manufacturing Practice (GMP) is used throughout the process.

Chilled Vacuum Packed Octopus

The process flowchart provided by the manufacturer appears sound, although the lack of documented quality assurance records is a concern. Additional steps in the process may assist to extend the shelf life. A chilled water dip after cooking should prevent possible hot spots and prolonged cooling which could significantly affect the microbial levels and lead to variation in the shelf life. A chlorinated wash prior to vacuum packing would also significantly reduce the initial microbiological load of the octopus.

The final product assessed displayed poor seals and incorrect packaging for a vacuum product. This was discussed in more detail in the shelf life discussion where recommendations were made.

BBQ Octopus

This process has several areas of concern, most relating to the addition of the BBQ sauce where no processing aids are employed to assist shelf life. Extended shelf life can be obtained through lowering pH (increasing acidity) or water activity (Aw), by using preservatives or through heat treatment such as sterilisation, pasteurisation or even hot filling.

Literature on the use of the above processing aids can be found in most libraries. Three books of good quality are C.M.D. Man and A.A. Jones (1994) *"Shelf life Evaluation of Foods"*, Blackie Academic, London; Shapton, D.A. (eds) and Shapton, N.F. (eds) (1991) *"Principles and Practices for the Safe Processing of Foods"*, Butterworth-Herinemann, Oxford; and Binstead, R., Devey, J.D. and Dakin, J.C. (1971) *"Pickle and Sauce Making"*, 3rd edn Food Trade Press, London.

Pickled Octopus

The current process appears sound. The use of hurdle technologies appeared to have controlled microbiological growth as seen by the shelf life results (Appendix 1). It is suggested that the pH be reduced to 4.0 or below to give the added assurance of a consistent, safe product (analysis showed pH ranging between 4.1 and 4.4). In Step 12 appendix 3 the addition of oil is questioned as to its function and necessity. The oil remains immiscible on the surface and may become prone to yeasts, moulds and oxidation. Again the above literature should be of assistance in improving the process.

As mentioned earlier, the absence of a documented QA system is of concern. It is strongly recommended that this be remedied immediately and incorporated into a HACCP plan. Any litigation brought against the company would be indefensible without a documented system.

Appendix 1A

VACUUM PACKED OCTOPUS - ANALYTICAL RESULTS

Tests / *Day/Temp*	SPC per g	Yeasts per g	Moulds per g	Anaerobic spores per g	TVN per g	Water Activity
Day 1 Initial Testing	2100	100	<100	<100	N/a	0.98
Day 7 Temp 4°C	740,000	3700	<100	<100	N/a	N/a
Day 7 Temp 10°C	>1000000	900	<100	<100	N/a	N/a
Day 9 Temp 4°C	960000	7400	<100	<100	26.2	N/a
Day 9 Temp 10°C	>1000000	4100	1100	<100	N/a	N/a
Day 14 Temp 4°C	>1000000	1300	<100	<100	N/a	N/a
Day 14 Temp 10°C	>1000000	35000	1000	N/a	N/a	N/a

Appendix 1B

OCTOPUS IN BARBEQUE SAUCE - ANALYTICAL RESULTS

Tests / *Day/Temp*	SPC per g	Psychro trophic spores per g	Yeasts per g	Moulds per g	Lactic acid bacteria per g	pH	Water Activity	Salt %	Acidity % acetic acid
Day 0 Initial	4900	N/a	<100	<100	<100	4.63	0.96	0.41	0.39
Day 21 Temp 4°C	11000	N/a	1100	200	<100	5.00	N/a	N/a	N/a
Day 21 Temp 10°C	64000	N/a	15000	<100	<100	4.90	N/a	N/a	N/a
Day 57 Temp 4°C	55000	6000	41000	1100	<100	4.87	N/a	N/a	N/a
Day 57 Temp 10°C	420000	N/a	>100000	<100	<100	5.02	N/a	N/a	N/a
Day 84 Temp 4°C	670000	N/a	>100000	<100	<1000	4.97	0.97	N/a	0.44
Day 84 Temp 10°C	20000	N/a	12000	<100	<10000	4.96	N/a	N/a	N/a

Appendix 1C

PICKLED OCTOPUS - ANALYTICAL RESULTS

Tests / *Day/Temp*	Storage Temp	SPC per g	Yeasts per g	Moulds per g	Lactic Acid Bacteria per g	Psychrotrophic spores per g	pH	Aw	Salt %	Acidity % acetic acid
Initial Testing	Received 3°C	<10	<100	100	<100	N/t	4.34	0.98	0.92	1.26
Day 21 Month 1	4°C	<10	<100	<100	<100	N/t	4.11	N/t	N/t	N/t
Day 21 Month 1	10°C	<10	<100	<100	<100	N/t	4.30	N/t	N/t	N/t
Day 57 Month 2	4°C	<10	<100	<100	<100	<100	4.45	N/t	N/t	N/t
Day 57 Month 2	10°C	<10	<100	<100	<100	N/t	4.48	N/t	N/t	N/t
Day 84 Month 3	4°C	<10	N/t	N/t	<100	N/t	4.45	N/t	N/t	N/t
Day 84 Month 3	10°C	<10	N/t	N/t	<100	N/t	4.39	N/t	N/t	N/t
Day 107 Month 4	4°C	<10	N/t	N/t	<100	N/t	4.43	N/t	N/t	N/t
Day 107 Month 4	10°C	100	N/t	N/t	<100	N/t	4.42	N/t	N/t	N/t
Day 131 Month 5	4°C	<10	N/t	N/t	<100	N/t	4.38	N/t	N/t	N/t
Day 131 Month 5	10°C	<10	N/t	N/t	<100	N/t	4.41	N/t	N/t	N/t
Day 161 Month 6	4°C	<10	<100	100	<100	<100	4.27	1.09	N/t	0.98
Day 161 Month 6	10°C	<10	<100	<100	<100	N/t	4.26	1.0	N/t	0.98

Appendix 2A - Sensory Characteristics Chilled Vacuumed Packed Octopus

Day	Storage Temp	Odour	Colour	Taste	Texture	Appearance
Day 2	4°C	Strong oily fish odour similar to canned tuna.	Off white / cream.	Strong fishy flavour.	Legs - firm moist. Body - Semi firm.	No staining or signs of autolysis, some skin still present on legs.
Day 7	4°C	Strong oily fish odour similar to canned tuna.	Off white / cream.	Body - Strong fish. Legs - Mild fish flavour.	Body - Semi firm. Legs - Soft.	Firm to touch, slightly greasy
Day 7	10°C	Sharp fish / slightly bitter.	Light tan / grey	N/A	N/A	Colour going grey / tan, slight slime build up. Legs still appear firm, Body starting to decompose.
Day 9	4°C	Moderate bitter / sharp stale odourl	Light Tan / grey	N/A	N/A	Definite slime build up, still firm to touch
Day 9	10°C	Strong bitter / sharp stale odour	Dark tan/ grey	N/A	N/A	Large amount of slime, product becoming putrid
Day 14	4°C	Moderate bitter / sharp stale odour	Dark tan/ grey	N/A	N/A	Suckers falling off, large amount of slime present, body very soft, legs softening.
Day 14	10°C	Distinctively rancid	Dark tan/ grey	N/A	N/A	Mushie, slimy, putrid.

Appendix 2B - Sensory Characteristics BBQ Octopus.

Day	Storage Temp	Odour	Colour	Taste	Texture	Appearance
Day 2	4°C	Rich oily BBQ odour with slight burnt aroma. Very clean smell	Sauce - dark brown / red Octopus off white/ light tan penetrating about 1/3 through body.	Rich oily BBQ flavour with rich spicy after bite.	Legs - Firm / moist Body - Semi firm / moist	Dark red brown layer, some oil becoming immiscible on the surface.
Day 21	4°C	Rich oily BBQ odour with slight burnt aroma. Very clean smell.	Sauce - Dark brown Octopus - surface brown penetrating into flesh, inner flesh becoming greyish.	Rich oily BBQ flavour with rich spicy after bite.	Legs - Firm / moist Body - Semi firm / moist	Oil coming out of suspension to form an immiscible layer on the surface
Day 21	10°C	Rich oily BBQ odour with slight burnt aroma. Very clean smell.	Sauce - Dark brown Octopus - surface brown penetrating into flesh, inner flesh becoming greyish.	Rich oily BBQ flavour with rich spicy after bite.	Legs - Firm / moist Body - Semi firm / moist	Oil coming out of suspension to form an immiscible layer on the surface
Day 57	4°C	Rich oily BBQ odour with slight burnt aroma. Still slight clean smell.	Sauce - Dark brown Octopus - surface brown penetrating into flesh, inner flesh becoming greyish.	Flesh becoming blander with loss of spicy after bite.	Legs - firm slightly rubbery	Greyish colour of flesh turning light brown, oil still immiscible on surface, mixes well with shaking.
Day 57	10°C	Rich oily BBQ odour with slight burnt aroma. Loss of clean smell. Odour slightly stronger when shaken.	Sauce - Dark brown Octopus - surface brown penetrating into flesh, inner flesh becoming greyish.	N/A	N/A	As above.
Day 84	4°C	Some loss of strong rich BBQ odour, slightly stronger when shaken	Sauce - becoming slightly lighter still brown. Octopus - no change from above	N/A	N/A	As Above A little more browning of cut muscle
Day 84	10°C	Very little odour without shaking.	As above	N/A	N/A	Mould growth occurring on surface, sauce has penetrated through whole muscle turning colour tan / light brown.

Appendix 2C - Sensory Characteristics Pickled Octopus

Day	Storage Temp	Odour	Colour	Taste	Texture	Appearance
Day 2	4°C	Fresh vigorous vinegar with spicy residual odour.	Flesh - External off white / cream, Internal white. Pickle - slightly cloudy.	Sharp crisp acidic flavour with residual spicy after bite.	Firm / Moist.	Mustard and some pepper seeds on bottom of container, legs still show light pink coloured skin.
Day 21	4°C	Fresh vigorous vinegar with spicy residual odour.	Flesh - External off white / cream, Internal white. Brine - becoming cloudy.	Sharp crisp acidic flavour with residual spicy after bite.	Firm / Moist.	Settling of peppers and mustard seeds. Oil becoming immiscible on surface.
Day 21	10°C	Freshness dissipating, spicy residual odour remaining.	Flesh - External off white / Cream which is starting to penetrate into flesh. Brine - cloudy	Acidic flavour with residual spicy after bite but loss of freshness.	Firmness increasing some loss of moist mouth feel.	Settling of peppers and mustard seeds. Oil becoming immiscible on surface.
Day 57	4°C	Sharp acidic odour, loss of freshness and some spicy residual odour.	Flesh - External off white / cream which is starting to penetrate into flesh. Brine - cloudy	Acidic flavour with residual spicy after bite but loss of freshness.	Firm loss of most moist mouth feel.	Pink colouration of skin has browned. Otherwise similar to above.
Day 57	10°C	Strong pickled odour compared to acidic odour of 4°C.	Flesh - body becoming darker, penetration white / cream same as day 21. Brine - cloudy.	Slightly acidic to vinegary, no crispness left. A slight spicy aftertaste remaining.	Legs firm to tough. Body soft but loss of moist mouth feel	Thin oil layer on surface, brine slightly clearer than 4°C.
Day 84	4°C	Similar to day 57, 4°C odour becoming slightly more pickled (acidic). Loss of freshness and spicy residual odour.	Flesh - Body cream / light tan Legs white / cream penetration slightly greater than day 57, 4°C. Brine cloudy.	Acidic to vinegary, no crispness left, Very faint spicy residue remaining.	Legs firm to tough with loss of moist mouth feel. Body soft and slightly dry / fibrous.	Brine very milky, skin starting to pull away from muscle and is quite bleached. Distinct colour difference in leg between surface and core.
Day 84	10°C	Strong pickled odour.	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Acidic to vinegary, no crispness left, Loss of spicy residual after bite.	Legs firm to tough, Slightly rubbery. Body soft but loss of moist mouth feel	Brine slightly clearer then at 4°C. Skin starting to pull away from muscle and is quite bleached. Distinct colour difference in leg between surface and core.

Day	Storage Temp	Odour	Colour	Taste	Texture	Appearance
Day 107	4°C	Dull pickled odour	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Dry vinegary flavour. All freshness lost	Legs firm to rubbery	Skin pieces falling off legs. Difference when compared to fresh product distinctive and less appealing.
Day 107	10°C	Dull pickled odour	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Dry vinegary flavour. All freshness lost	Slightly more rubbery then at 4°C	Skin pieces falling off legs. Difference when compared to fresh product distinctive and less appealing
Day 131	4°C	Dull pickled odour	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Dry vinegary flavour. All freshness lost	Slightly more rubbery then at 4°C	Skin pieces falling off legs. Difference when compared to fresh product distinctive and less appealing
Day 131	10°C	Dull pickled odour	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Dry vinegary flavour. All freshness lost	Slightly more rubbery then at 4°C	Skin pieces falling off legs. Difference when compared to fresh product distinctive and less appealing
Day 161	4°C	Dull pickled odour	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Dry vinegary flavour. All freshness lost	Slightly more rubbery then at 4°C	Skin pieces falling off legs. Difference when compared to fresh product distinctive and less appealing
Day 161	10°C	Dull pickled odour	Flesh - Body light tan Penetration of light cream colour into legs about 1/3 to ½. Brine cloudy.	Dry vinegary flavour. All freshness lost	Slightly more rubbery then at 4°C	Skin pieces falling off legs. Difference when compared to fresh product distinctive and less appealing

Appendix 3a- Flow diagram of chilled vacuum packed octopus

1.	Product Receivals	
2.	Frozen storage	
3.	Thawing	
4.	Gutting	
5.	Tumbling	
6.	Butchering	
7.	Cooking	
8.	Chilled storage	* Recommend chilled water dip
9.	Weighing	*Recommend chilled chlorinated water dip
10.	Vacuum packaging	
11.	Chiller / Freezer	
12.	Dispatch	

Appendix 3b- Flow diagram of BBQ octopus

1.	 Product Receivals	
2.	 Frozen storage	
3.	 Thawing	
4.	 Gutting	
5.	 Tumbling	
6.	 Butchering	
7.	 Cooking	
8.	 Chilled storage	
9.	 Dicing octopus	
10.	 Mixing sauce	*Recommend Heat treatment
11.	 Packing/Labelling	
12.	 Chilled storage	
13.	 Dispatch	

Appendix 3c- Flow diagram of pickled octopus

1.  Product Receivals
2.  Frozen storage
3.  Thawing
4.  Gutting
5.  Tumbling
6.  Butchering
7.  Cooking
8.  Chilled storage
9.  Dicing octopus

10.  Mixing pickle
11.  Heating
12.  Spice addition Oil addition

13.  Packing
14.  Labelling
15.  Chilled storage
16.  Dispatch

Appendix 4 - Questionnaire - Tasmanian Octopus Products Pty Ltd

Q1. Do you have any formal quality assurance system in place?

Yes [No]

If yes, what type? Hazard HACCP ISO Other

Q2. Do you have any written standard operational procedures (SOP)?

Yes [No]

Q3. Do you have any written product specifications that may or may not include recipes?

[Yes] No

Q4. Do you have any on line quality control / assurance?

[Yes] No

If Yes how is it documented?

Form tables log [Other]

Q5. Do you conduct any Post product quality assurance on the finished product?

[Yes] No

If yes, what type? [Sensory] Shelf life Microbial Chemical

Q6 Do you have machines that require Calibration? i.e. Scales, thermometers, steam jacketed cookers

[Yes] No

If yes what type and how often?

Scale calibration once per year

Q7. Do you have any maintenance procedures for your equipment?

Yes [No]

Q8 Do you have a documented cleaning procedure

[Yes] No

If yes, briefly outline procedure including chemicals used?

Chlor foam is used as a cleaning agent

The following questions relate to the specifics of your process.

Q9 Please outline the process as it is carried out in your factory for each of the following products.

Pickled octopus
BBQ marinated octopus
Chilled vacuumed packed octopus

See Appendix 3

Q10. Is the Sauce hot or cold filled?

Pickles [Yes] Cold

Marinate Hot [Cold]

If hot is the temperature regulated?

[Yes] No

If Yes at what temperature? Pickles 100°C Marinate N/a

Q11. Do you make fresh marinades/ pickles for each batch?

Pickle [Yes] No

Marinate Yes [No]

If No, How do you store?

Pickle is made fresh
Extra marinade is stored in the cold store until required.

If no, do you reheat before use?

Pickle Yes No [N/a]

Marinate Yes [No] N/a

Q12 Do you use fresh octopus for each batch?

Yes [No]

If No, How do you store it?

Most octopuses are fresh, some may be frozen.

What is its storage life?

Pickles - 6 months

Marinate - 3 months