

Prevention of Contamination of Rendered Meal and Tallow by Foreign Matter

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Contamination in the Media



THE SENATE

RURAL AND REGIONAL AFFAIRS AND TRANSPORT REFERENCES COMMITTEE

Regulatory approaches to ensure the safety of pet food

Submissions 27 July. Public hearings 28 & 29 Aug.

Regulatory approaches to ensure the safety of pet food:

- uptake, compliance and efficacy of the Australian Standard for the Manufacturing & Marketing of Pet Food (AS5812:2017);
- labelling & nutritional requirements;
- AVA-PFIAA administered PetFAST tracking system;
- independent body to regulate pet food standards, or an extension of Food Standards Australia New Zealand's remit;
- voluntary and/or mandatory recall framework of pet food products;
- international approaches to the regulation of pet food.

“Needles in strawberry sabotage exposes vulnerability of food industry”

Approx. \$250mil in lost revenue due to ~0.00001% contamination of an estimated of 60 million punnets p.a.

Estimated at 0.0003 ppm contamination

<https://www.news.com.au/finance/business/manufacturing/no-point-getting-up-in-the-morning-needle-crisis-puts-500-million-strawberry-industry-at-risk/news-story/3b4ee61cac9190ad555f6eebd77e5084>

<https://www.dailytelegraph.com.au/news/dramatic-method-to-get-australian-strawberries-back-on-shelves/news-story/9bfa73d62aa2c501fa8c89d755c50c34>

Project Overview

- **M1:** source and type of contaminant; KPIs. “Clean and Green”.
- **M2:** Lab testing.
- **M3:** education materials.
- **M4:** education sessions. Webinar. Melbourne Sept/Oct.
- **M5:** Mechanical separation / automated detection with associated quotes from market for trial / Proof of Concept i.e. via case studies or data sheets. 1/10/2018
- **M6:** materials of construction (e.g. renderable) with associated quotes from market for trial / Proof of Concept i.e. via case studies or data sheets. 1/10/2018
- **M7:** Measurement of impact against KPIs.
- **M8:** Final report and Snapshot.



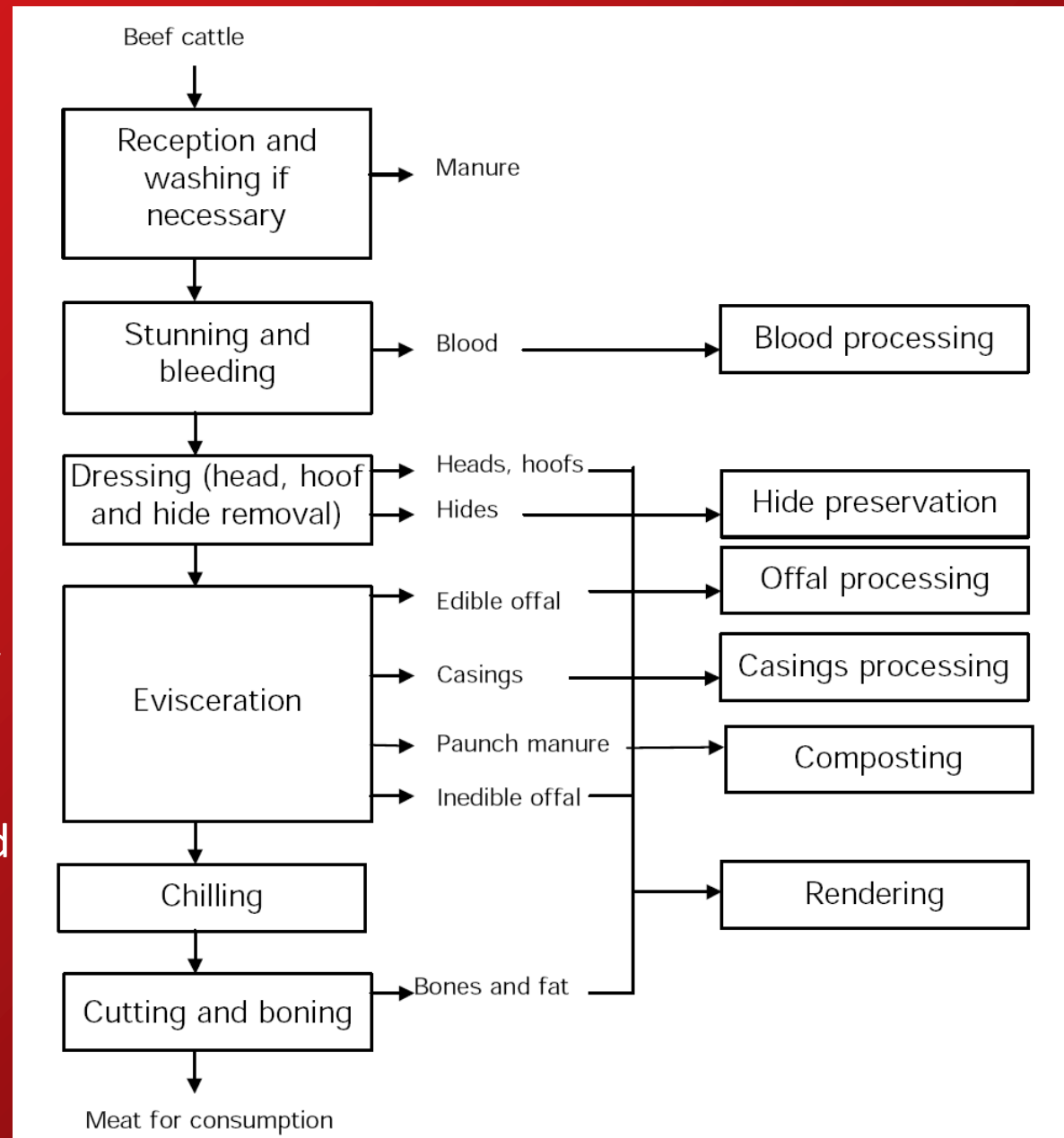
Rendering

Almost half (~42%) by mass per animal is sent to rendering.

Rendered products (tallow and meal) can represent around 8 to 10% of annual revenue for a meat processor.

2.45 kg / day of polyethylene (PE) will exceed the 50 ppm PE in tallow levels for a “typical” rendering facility. However, this material can build up over time then be released in a “plug”.

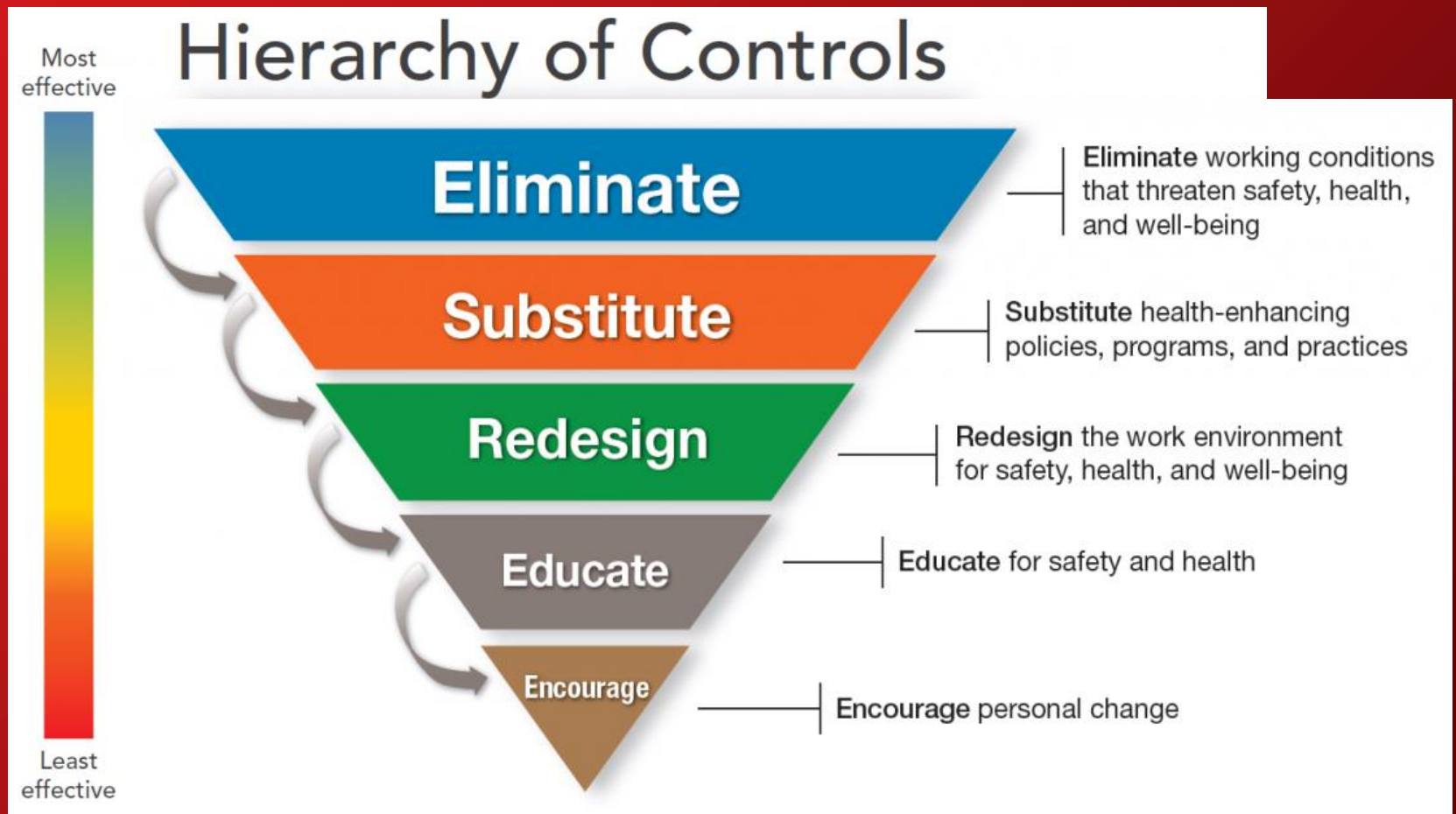
A rendering facility aggregating from different sources may expect 37 tpa of mixed contaminant waste (i.e. plastic) and 17 tpa metal.



Source: *Cleaner Production assessment in Meat Processing*, Chapter 2 “Overview of Meat Processing”.

Options for Preventing Contamination

A [Hierarchy of Controls](#) is used to determine the most feasible and effective solutions that can control hazards. The control methods range from the most effective at the top to the least effective at the bottom. By following this hierarchy, organizations can reduce risks of incidents.



M1: source and type of contaminant



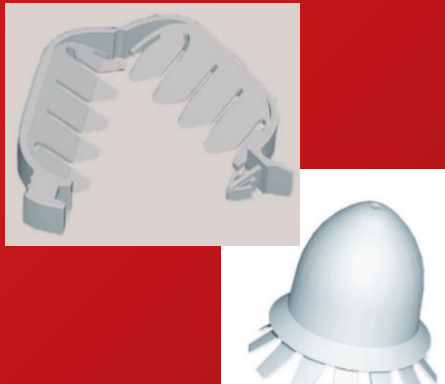
Liners and plastic films:
Low density
Polyethylene (LDPE)



Gloves, hair nets,
ear plugs.



Metal from equipment
and knives; Tramp metal



Clips and plugs










Medicinal
boluses



Ear tags and
ceramic RFIDs

M1: source and type of contaminant; KPIs. “Clean and Green”.

Item	Material of Construction	# per annum throughout Australia	\$/unit [\$ pa typical processor]	Tonnes per annum polymer	Image
Beef bungs	100% recycled paper, waxed “breaks down in the rendering process”, FDA food contact approved	7,639,824	\$0.525/unit [\$78,750 pa typical beef plant]	61.12	
	100% recycled paper, unwaxed, “breaks down in the rendering process”, FDA food contact approved		\$0.339/unit [\$50,790 pa for a typical beef plant]		
	Plastic, FDA food contact approved		\$0.314/unit [\$47,113 pa for a typical beef facility]		
	Water soluble, FDA food contact approved (Note: anticipated to be a vegetable starch based material)		\$0.251/unit [\$37,688 pa for a typical beef facility]		
	Rice husk which “breaks down in the rendering process”				
Ear tags visual ear tag or an RFID ear tag.	polyurethane10	Up to 41.1 mil (30.6 mil beef, 7.6 sheep lamb, 0.9 mil cattle exported, 1.95 mil of sheep exported and 0.01 mil goats.			
Veterinary gloves	HDPE/LDPE Film				
Bags and bin / carton liners	Typically made from high-density polyethylene (HDPE), low-density polyethylene (LDPE), or linear low-density polyethylene (LLDPE).				
Metal from feedstock and/or equipment	Steel, galvanized steel				Iron filings and metal pieces from equipment wear.
Wood / organics	Paper, ligno-cellulosic				
Face/dust masks and hair nets.	PP, mixed fibre material, Nylon, PE. Elastic (spandex, polyester, cotton, nylon or fibre blends) or rubber straps				

Rumen bolus	Ceramic + RFID				
Hormonal Growth Promotant (HGP)	Silicon rubber or; Compressed cholesterol / lactose, along with a metal ball (mild steel, carbon steel) for pellet implantation ¹¹ .				
Rumen medicinal bolus	3” long polymer device load with medicine for delivery up to 12 months; wings to increase residence time mild steel spring for drug delivery.				
Gloves	Latex, nitrile, rubber, polyvinyl chloride and neoprene				
Vacuum / Cryovac packaging	Polyamide (PA; for puncture resistance) and PE for sealing. Prevention of oxygen permeability via polyvinylidene chloride (PVDC) and ethylene vinyl alcohol (EVOH).				
Lamb/sheep clips	Plastic, FDA food contact approved	30,593,660	\$0.058/unit [\$28,892 pa for a typical facility]	122.37	
	Rubber		\$0.086/unit [\$43,125 pa for a typical facility]		
(Or O-rings for oesophagus (sheep, cattle))					
Lamb/sheep bungs	100% recycled paper ⁹	30,593,660	\$0.079 / unit [\$39,533 pa for a typical facility]	139.86	
	Plastic, FDA food contact approved		\$0.12/unit [\$60,000 pa for a typical facility]		
Beef clips (Weasand clip)	Polyoxymethylene (POM) plastic, also known as “acetal” or “polyacetal”. Polyoxymethylene or “acetal” is an engineering thermoplastic used in precision parts requiring high stiffness.	7,639,824	\$ 0.098 / unit [\$14,696 pa for a typical beef facility]	53.48	
					

M1: Detailed Polymer Contamination Physical Characteristics

High tem rendering: >100 °C (often reaching 110 to 130) results in softening of PE at 80 oC with completely fluid PE from 100 – 126 oC.

Low temperature rendering at 70 to 100 (routinely 88 °C) resulting in PE not becoming fluid. However, temperature gradients / poor mixing could melt some PE.

With its low melting temperature, the different forms of Polyethylene (PE) provide the greatest source of contamination within the rendering process.

Contaminant		Contaminant Source	Melting Point (degC)	Reference/Source
HDPE	High-density polyethylene		126 -135	CHEMnetBASE, Polymers: A Property Database
LDPE	Low-density polyethylene		105 -115	CHEMnetBASE, Polymers: A Property Database
LLDPE	Linear low-density polyethylene	Bags, gloves, liners	100 - 120	CHEMnetBASE, Polymers: A Property Database
PE	Polyethylene		135 - 142.6	CHEMnetBASE
PET	Polyethylene terephthalate	Bottles	267	
PVC	Polyvinyl Chloride	Gloves, Piping	212	
PVDC		Cryovac	200	
EVOH	Ethylene Vinyl Alcohol	Cryovac	280	
PP	Polyprop	Face/dust masks and hair nets.	160	
acetal	Polyoxymethylene / polyacetal	Clips	175	
PU	Polyurethane	Tags	240 (Processing Temperature 227 – 260)	http://www.efunda.com/materials/polymers/properties
Wool		Feedstock	228-230 (ignition)	
Cotton		PPE	250 (ignition)	
Rubber		PPE	260-316 (ignition)	
PA Nylon / Polyamide		PPE; Cryovac	220 (ignition)	

High temperature rendering (>100 °C, often reaching 110 to 130) tends to result in softening of PE at 80 oC with completely fluid PE from 100 – 126 oC (depending upon the density) versus low temperature rendering at 70 to 100 (routinely 88; resulting in PE not becoming fluid) to achieve phase separation between the fats and other rendered materials.

M1: Formal specifications versus client request – meal.

Example: ARA/SFMAA SPECIFICATION MBM 45 CSPA-7 4

Colour- light to dark brown

Texture – 98% @ 2mm, 100% @5mm

Minimize microbiological contamination

Crude Protein – Min 45% on an “as is” basis.

Crude Fat – Max 15% on an “as is” basis.

Ash – Maximum 38% on an “as is” basis.

Crude Fibre – Max 3% on an “as is” basis.

Moisture – Min 4% Max 10%.

Salt – Maximum 1% on an “as is” basis.

Pepsin Digestibility Min 86% of protein

NIL ACCEPTANCE Toxic matter or chemicals prohibited by State laws against inclusion in stock feeds, or any substance harmful to animal health.

The product must be free from rodent and insect infestation.

Client specific / anecdotal:

- Maximum of 2% iron content in meal.
- Japan based client: must list all ingredients
- The Animal Proteins Standards 2015/16 makes no mention of allowable polymer but has a nil acceptance of toxic matter or chemicals prohibited by state law.

M1: Formal specifications versus client request – tallow.

Example: Pure Beef Tallow for export

FFA 1% maximum

MIU 1% maximum

FAC 11a maximum

R&B 0.4R maximum

Titre 42deg C minimum

FFA – Free Fatty Acids

MIU – Moisture / Impurities / Unsaponifiable

FAC – Fat Analysis Committee (colour scale)
1,3,5,7,9,11a


R&B – Bleachability (test for soap) (.2-.3)

Titre – melting/solidifies temperature

Client specific / anecdotal:

- Singapore: 50 ppm PE.
- Japan: must list all ingredients, including polymers.
- Industry standard (1973): 200 ppm PE.
- No visible flecks.

Rendering Mass Balance

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Average weight per head	kg/day	600	110 degree Celcius hot render 90% recovery of total solids to MBM 98% recovery of non MBM FOGs to tallow 2% losses of solids to stick water and evap 1 kg metal per tonne meal Personnal comm, Craig Mostyn I 0.04435 % total rendering stream 2.1 kg plastic per tonne mea Personnal communication, Craig Mostyn Pty Ltd 0.3% protein loss through NiR and Metal removal 8% % fat in MBM 1800 normal hepatic iron concentration is micrograms/g dry weight 0.180%																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												

0.96 kg / day of PE will exceed the 50 ppm tallow levels for a “typical” rendering facility.
 An aggregator may expect 37 tpa NiR material (plastic) and 17 tpa metal.

Contaminant Detection

Visual Inspection e.g. Flecks, dis-colouration

Gross contamination via traditional assays e.g. protein levels below target %.

Microscopy: visual inspection; dye/fluorescent assay e.g. Nile Red

Analytical / chemical analysis:

FTIR: Fourier transform Infra Red

Raman Spectroscopy

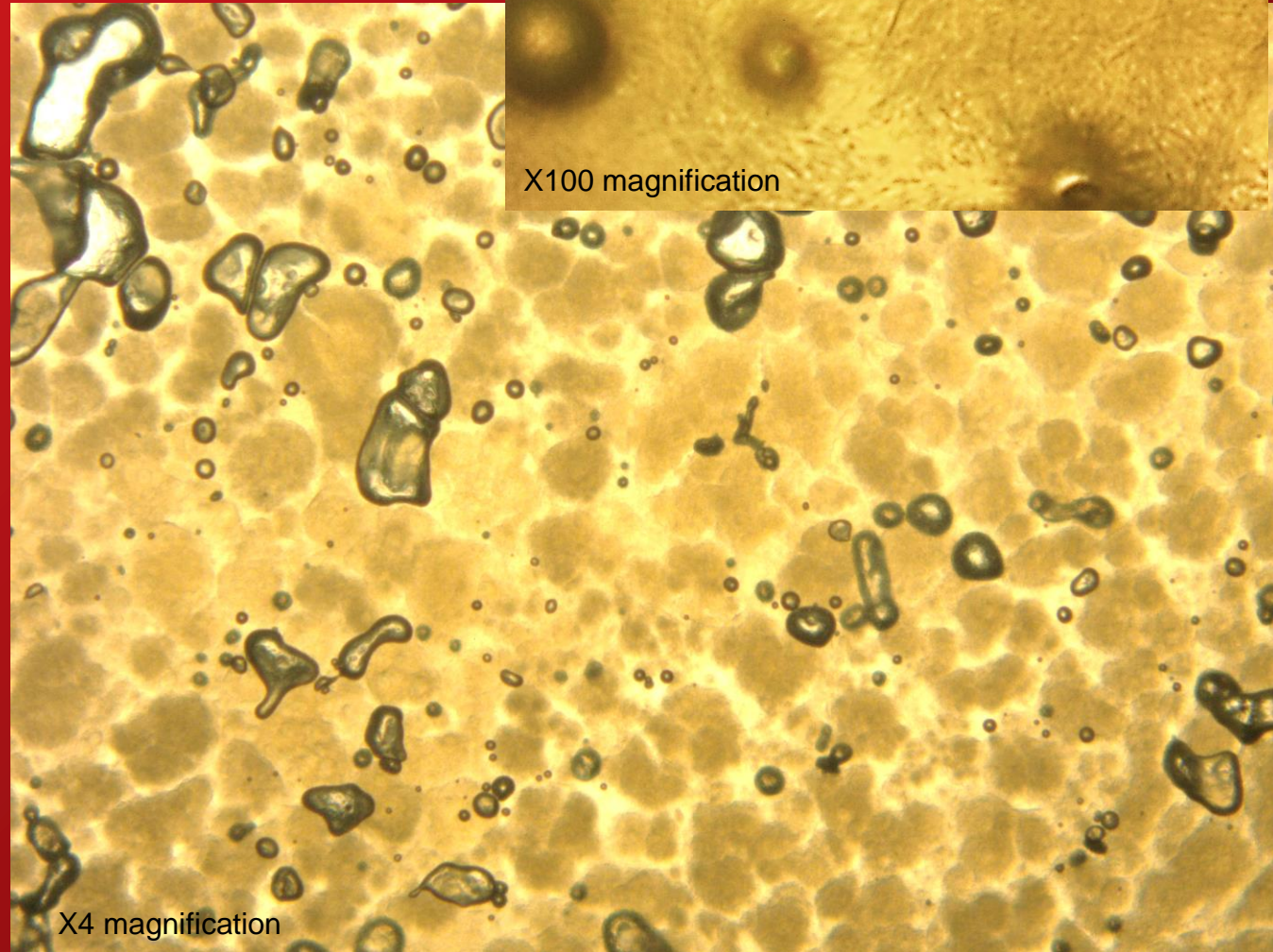
MS: Mass spectrometry

X-ray: detects variations in density

Magnetic: detects ferrous containing materials

Microscopy - Tallow

“Staining” can be used to highlight the presence of contaminants. Staining was trialled using a Nile Red stock solution (1 mg mL⁻¹) in acetone. An approximate contration of 10 µg mL⁻¹ and an exposure time of 30 minutes was used.



Lab results: Tallow

Analysis of Tallow sample N17410-1

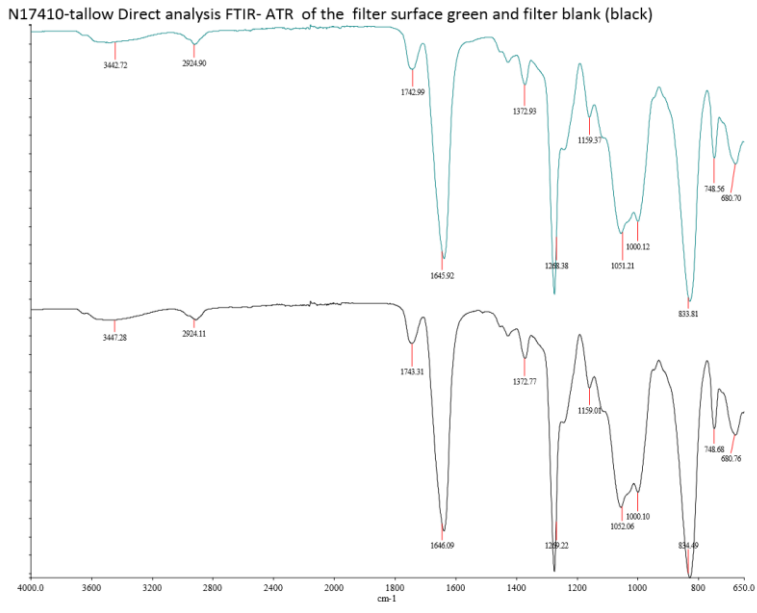
Approximately 100 g of tallow sample was dissolved in 100 ml of Methylene dichloride filtered through a pre-weighed nitrocellulose filter. The filter was washed, dried and weighed again to determine insoluble content in the samples. Material retained on the filters were analyzed using FTIR (Fourier Transform Infrared) spectroscopy in ATR (Attenuated Total Reflectance) mode on the 03/07/18 in transmission mode.

Sample	Insoluble component (ppm)
N17410-tallow	<1ppm

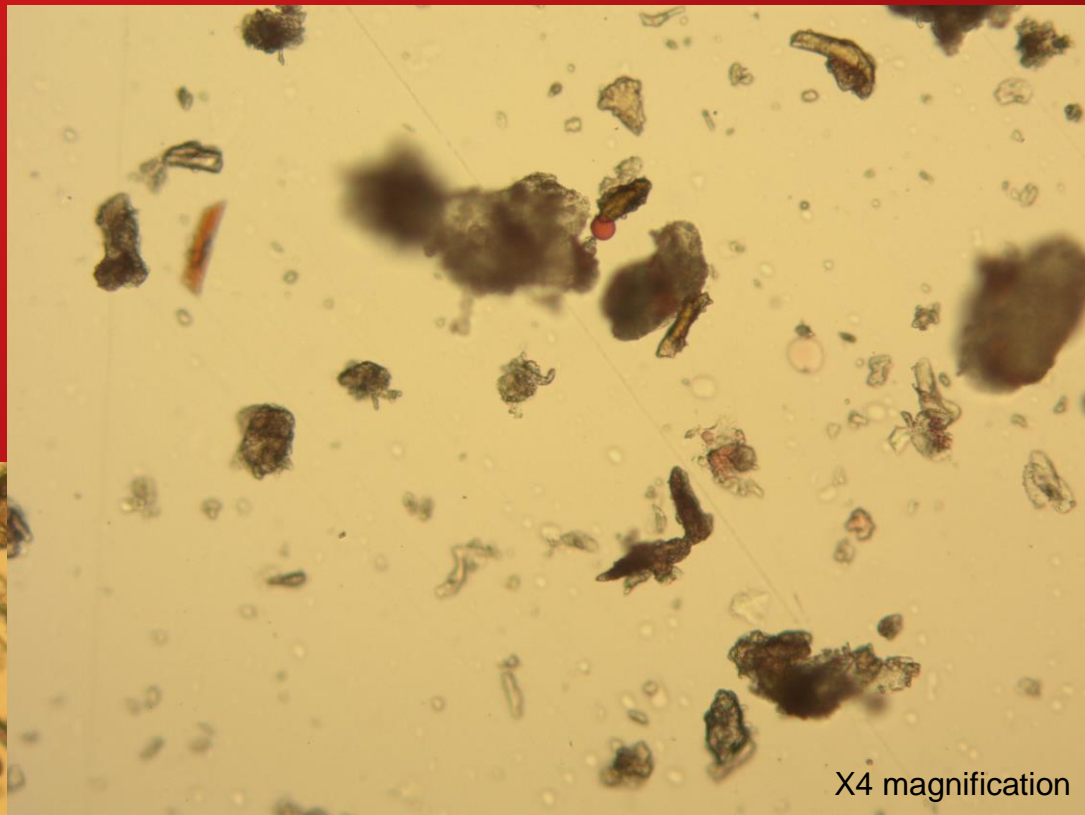
Little material was retained on the filter paper. Surface analysis of the filter- FTIR-ATR returned a similar spectrum to a blank filter paper (no material was detected) Under the optical microscope a number of small brown particles were observed. Two representative particles were analyzed by FTIR microscope. They returned a broad FTIR spectrum in the main typical of protein based materials ($\sim 1645\text{cm}^{-1}$). A second signal($\sim 1033\text{cm}^{-1}$) in the spectra may be indicative of inorganic silicate or carbohydrate based materials. The spectra were not consistent with the presence of micro plastics (polyolefins)

No polymer or contaminants detected in insoluble component.

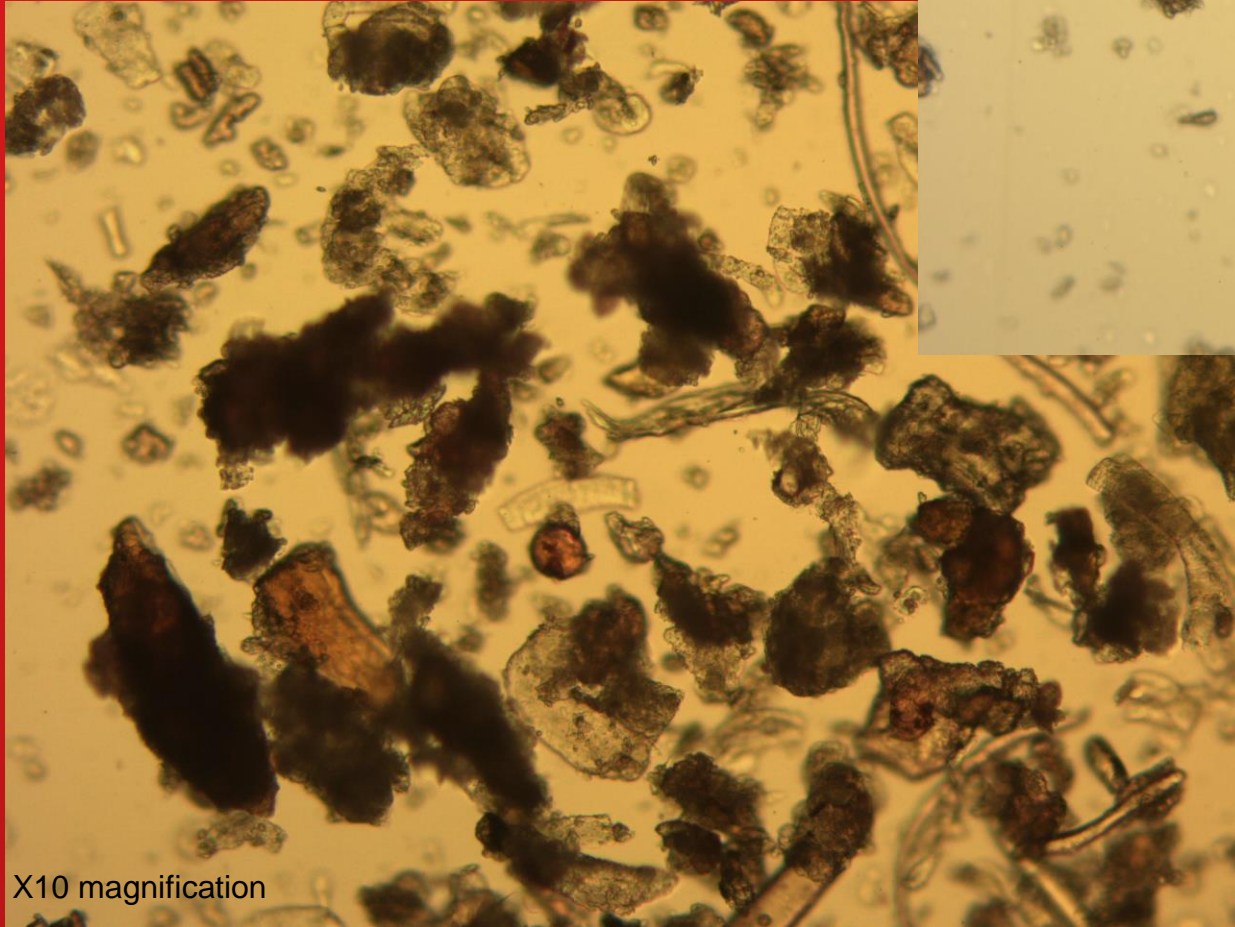
FTIR Analysis



Microscopy - Meal



X4 magnification



X10 magnification

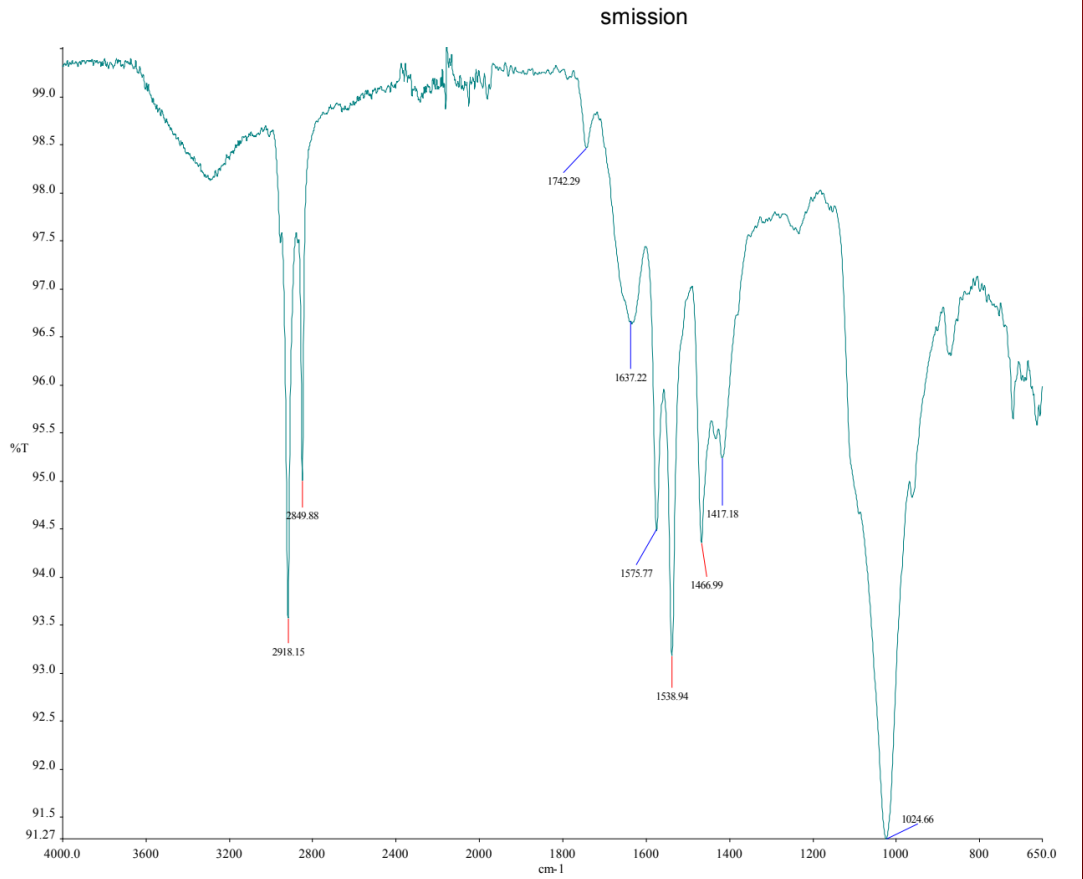
Lab results: Meal

Analysis of protein meal sample

Approximately 7.75g of sample was dissolved in 100 ml of water filtered through a pre-weighed nitrocellulose filter. The filter was washed, dried and weighed again to determine insoluble content in the samples. Material retained on the filters were analyzed using FTIR (Fourier Transform Infrared) spectroscopy in ATR (Attenuated Total Reflectance) mode on the 03/07/18 in transmission mode.

Sample	Insoluble component (%)
N17410- 2 protein meal	~approximately 1-0.5% in magnitude

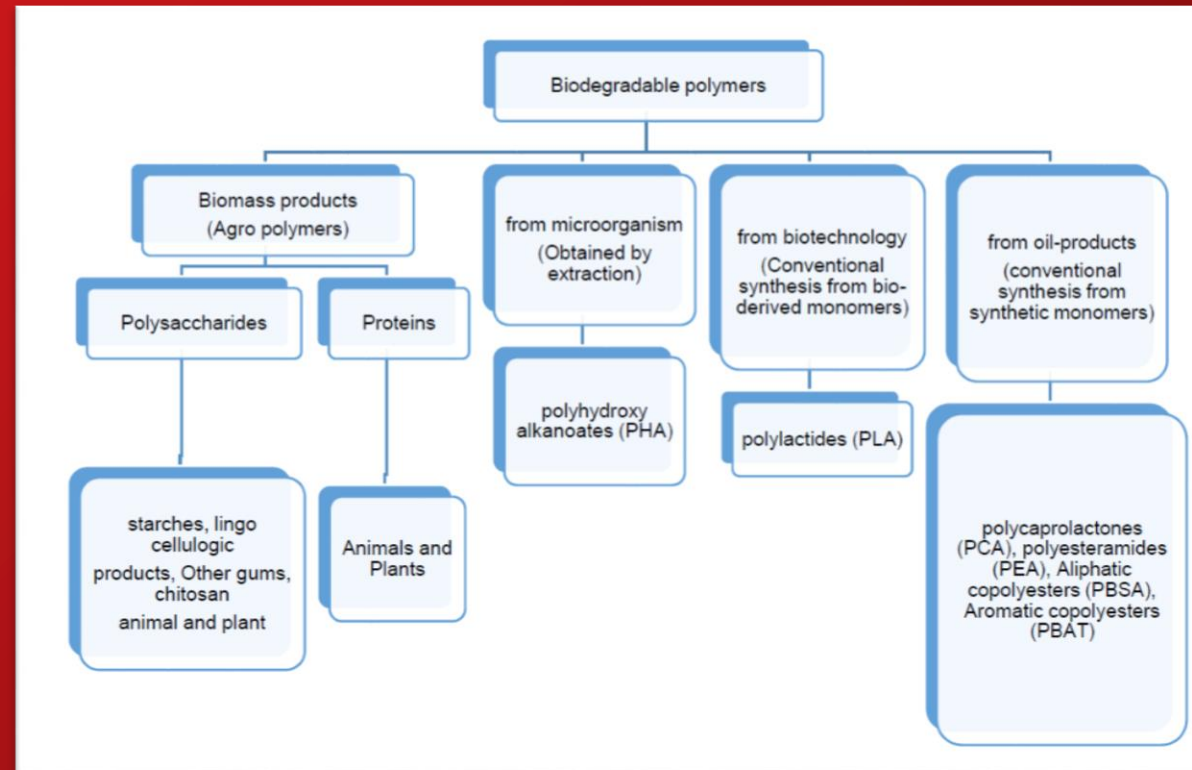
No polymer or contaminants detected in insoluble component.




M6: Materials of construction; Non-contaminating Polymer Alternatives

Want materials that are:

- 1) Made from material that will not contaminate tallow and can be milled / will degrade into meal whilst contributing to protein tonnage (i.e. protein base polymer),
- 2) Made from material that will not contaminate tallow and can be milled / will degrade into meal (i.e. plant based material),
- 3) Bio-degradable / compostable,
- 4) Non-toxic,
- 5) Food safe,
- 6) Can be detected and removed.



M6: Materials of construction; Non-contaminating Polymer Alternatives

- **Biodegradable thermoplastic polymer** made from starch / corn can be melt-processed via rendering. 4-week trial in 42 businesses using 0.88 mm liner and 57 businesses using 1.5 mm liner. No issues with conveyors, conveyor pumps, material grinders, production fat screens or filters, production fat centrifuges, fat work or finish storage, pipes, valves, or screens. “Poly count” test for polyethylene conducted at an independent lab showed that purposely adding 6,000 of the biodegradable, corn-based liners to the rendering cooker did not increase poly count. E.g. Mater-Bi (corn starch, cellulose, glycerin, and natural fillers), approved by the Food and Drug Administration for food contact.
- **Novatein bioplastic.** Remains intact after heat treatment. Can be milled into meal. From polymerized and extruded blood meal. \$0.0695 versus \$0.079 for a paper plug. Sample CBA for sheep plugs:

Original After 160 oC
- Advocacy by ARA to legislate against use of fossil / non-edible / non-biodegradable materials in the RMI supply chain?

Cost-benefit analysis comparing synthetic polymer devices to devices of different materials of construction.

Device	\$ pa device saving	\$ pa additional meal revenue	Avoided revenue loss (assumed at 1.53% of annual production)	Equipment protection	Equipment maintenance costs p.a.	Annual revenue / cost saving	Capex (\$)	Payback (years)	Notes
Renderable beef throat plug	\$33,438	\$ 414	\$ 130,000	Avoided PE fouling (difficult to quantify; assumed \$0)	NA	\$163,852	NA	Immediate	Same colour as meal
Renderable beef clip	-\$3,438	\$ 207	\$ 130,000	As above	NA	\$126,769	NA	Immediate	Same colour as meal
Renderable sheep bung	-\$4,586	\$ 1,756	\$ 37,182	As above	NA	\$34,352	NA	Immediate	Same colour as meal
Paper sheep bung	-\$11,592	NA	\$ 37,182	As above	NA	\$25,590	NA	Immediate	Different colour to meal
Soluble sheep bung	-\$27,940	NA	\$ 37,182	As above	NA	\$9,242	NA	Immediate	Different colour to meal
Soluble beef throat plug	\$9,844	NA	\$ 130,000	As above	NA	\$139,844	NA	Immediate	Different colour to meal
Beef Biodeg beef plug waxed paper	-\$32,969	NA	\$ 130,000	As above	NA	\$97,031	NA	Immediate	Different colour to meal
Beef Biodeg beef plug unwaxed paper	-\$ 3,906	NA	\$ 130,000	As above	NA	\$126,094	NA	Immediate	Different colour to meal
Magnetitic sep. system weasand clip: beef rendering	-\$4,594	NA	\$ 130,000	\$ 27,000	\$ 8,170	\$144,236	\$91,270	0.63	Separation efficiency relies upon exposure of contaminants to electro-magnet hence even spreading is required.
Magnetitic sep. system weasand clip: sheep rendering	-\$8667	NA	\$ 37,182	\$ 27,000	\$ 8,170	\$47,344	\$91,270	1.93	

M6: Materials of construction; Non-contaminating Polymer Alternatives

Opportunity:

[1] RMI develops MoU / places large order to expand type of devices available beyond just plugs.

[2] Fine chemicals production via microorganism (fungus; bacterial) conversion of RMI wastes into precursor

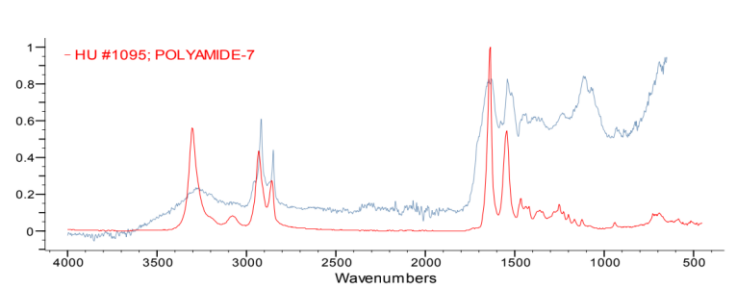
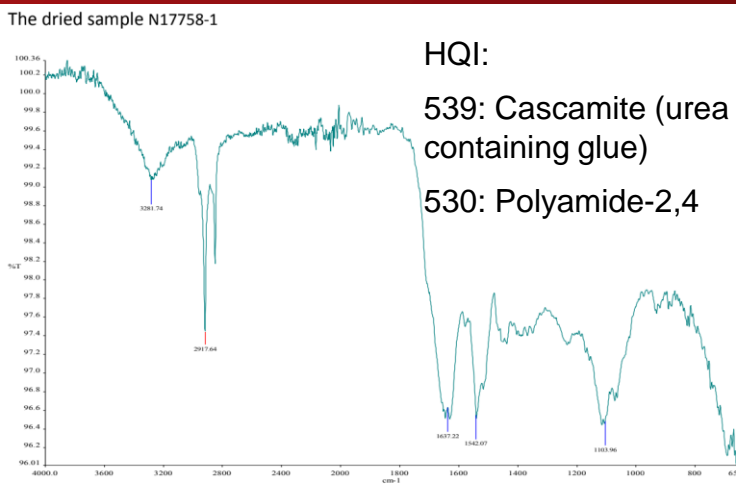
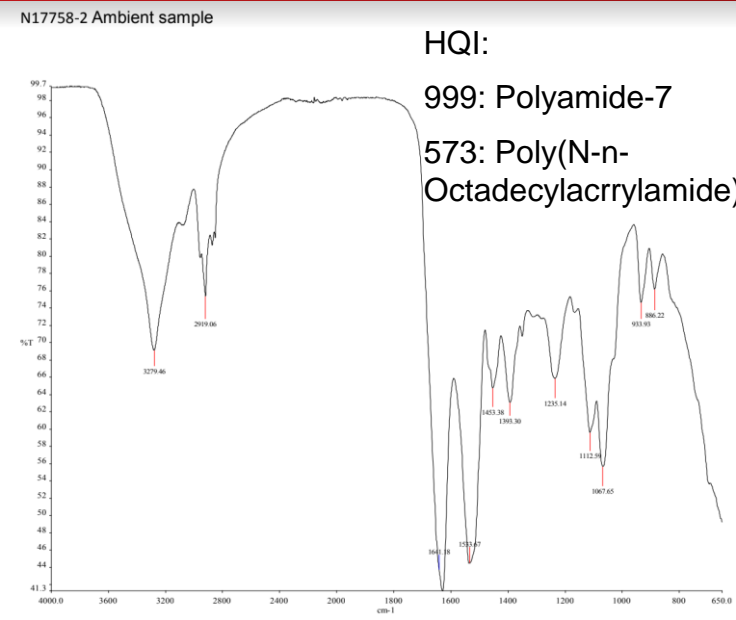
Loliware: edible plastic from seaweed agar (similar to gelatin), FDA approved, 24hr stability in water.

PHA: approved by FDA in 2014 for food contact material. Melting point 175 oC. Tensile strength of PP. Hydrophobic and non-toxic.

Novatein Protein Polymer Lab results:

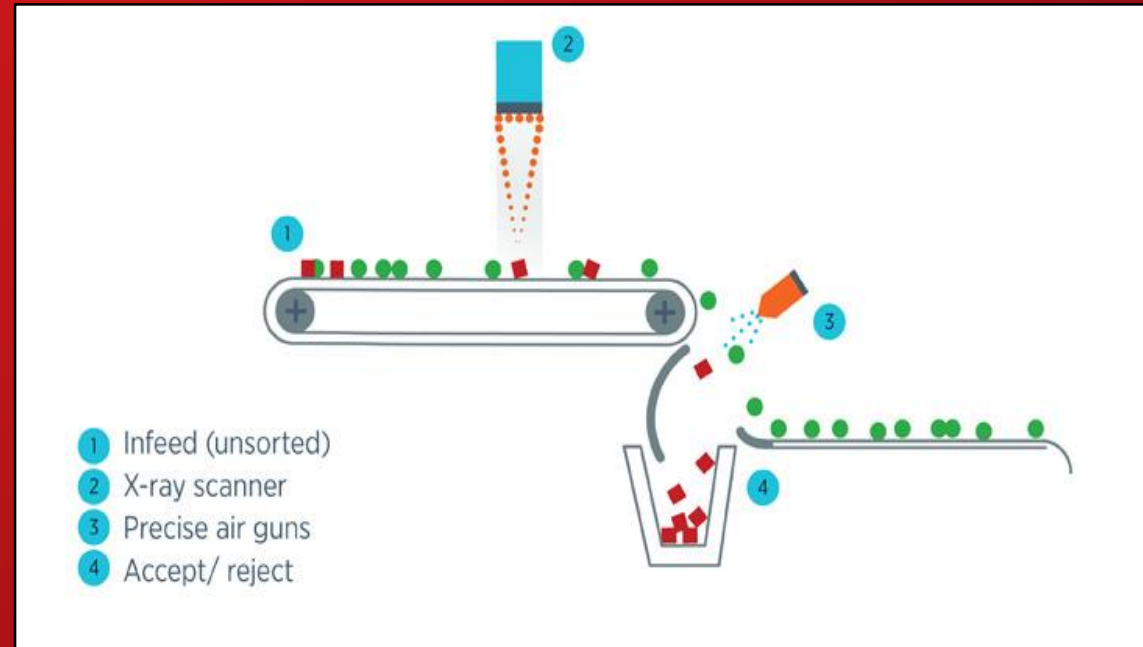
[1] Protein device: relatively clear spectrum of amide signals which is typical of protein-based materials but could also match nylon, derivatives of polyacrylamide and urea-based resin but the exact identity of this material was not determined due to the broader spectrum (typical for protein with nylon samples having a tighter spectrum). Examples of naturally occurring polyamides include proteins such as wool and silk. Artificial polyamides include nylons.

[2] Heat treated (160 oC) protein device: sample gave a similar (or related) spectrum to the non-heat treated sample with a spectrum that was further broadened suggesting degradation had occurred.



M5: Mechanical separation / automated detection

[1] Detection and removal: by material that has different density (X-ray) or light wavelength (near infra-red): plastic



[2] Direct removal via magnets / electro-magnets: stainless, ferro, rocks

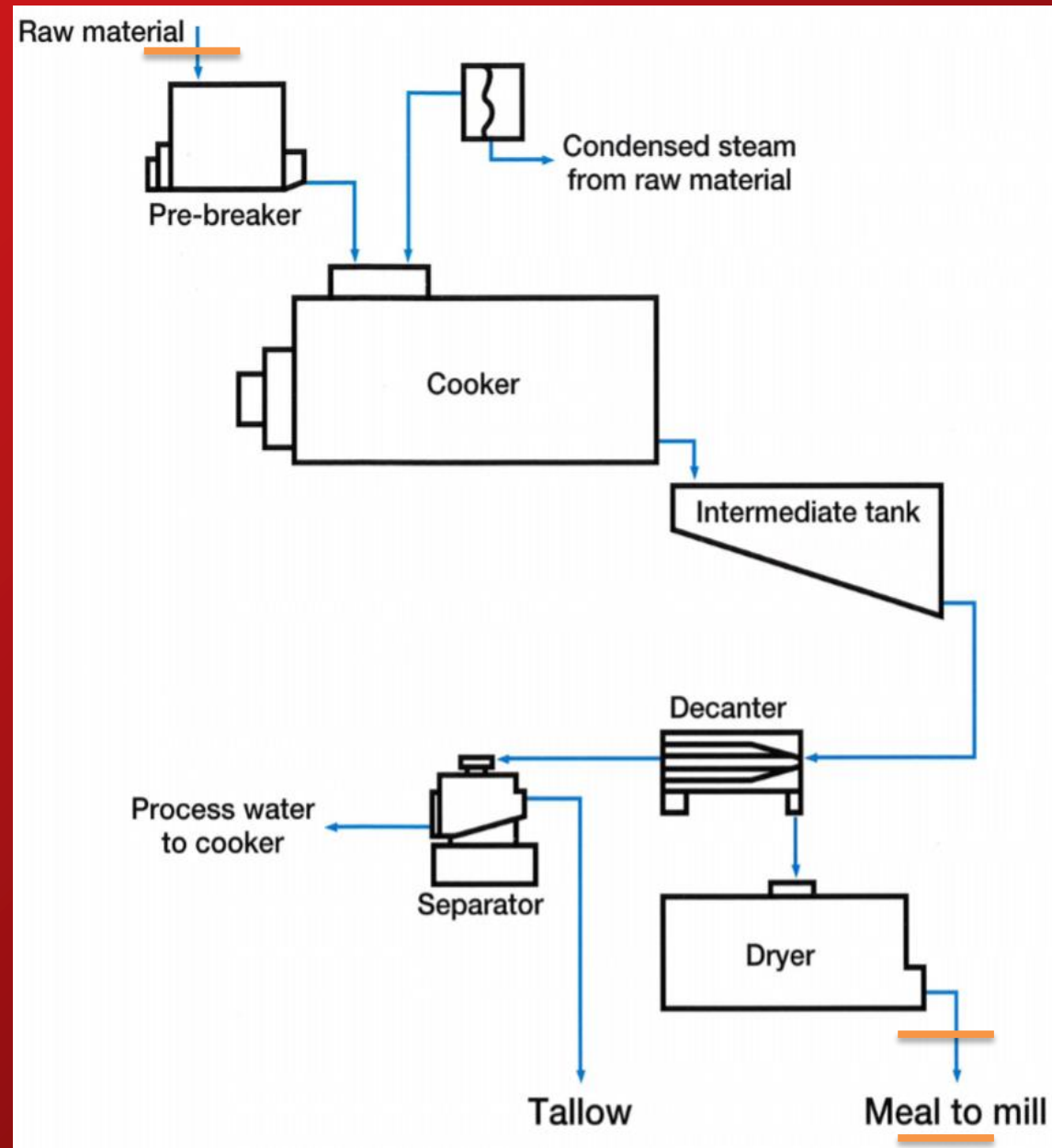


M5: Mechanical separation / automated detection

Main points of contaminant removal:

[1] Feed / raw material as it enters the plant. Contributes to protecting equipment from damage by metal.

[2] At the end of processing as part of Quality Control.



M5: Mechanical separation / automated detection

Stream Description	MBM50	Tallow (beef; edible)
Revenue per consignment (40' container / ISO tainer)	\$ 13,871	\$ 16,100
Revenue loss at 1% rejection	\$ 46,245	\$ 38,602
Revenue loss at 1.53% rejection	\$ 70,855	\$ 59,145
Revenue loss at 10% rejection	\$ 462,450	\$ 386,016
Revenue loss at 50% rejection	\$ 2,312,248	\$ 1,930,081
Revenue loss at 100% rejection	\$ 4,624,497	\$ 3,860,162
Revenue loss at chemical tanker rejection		\$ 18,257,093

- Simple payback periods ranged from 1.5 to 5 years.
- Target technologies that:
 - remove contaminants from the rendering feed as early as possible to protect equipment
 - remove all contaminants (metals and plastics).
- Removal of contaminants from wet render feed is highly innovative. Not yet undertaken for removal of all contaminants in a pre-render stream.

M3: Education materials.

Design aim: That foreign material contaminates products.

Marketing Collateral - poster, A4 to DL roll fold leaflet / pamphlet, web page, email campaign.

OPTION 1 - "Just Bin It". A clear, urgent call to take action on keeping ALL contaminants out of rendering feed.

JUST BIN IT.



Undetected foreign matter contaminates raw material **during rendering**, it ends up in food and is a major hazard to human and animal health.

M3: Education materials.

OPTION 2 - "Not in food". The designer uses the image (glove) of something that the viewer is familiar with and possibly uses on a day to day basis to get the message across "This belongs on your hand... Not in food!".

This belongs on your hand



Not in food!

During rendering unseen particles of foreign matter such as rubber gloves, plastic, metal, boluses and wood contaminates food for humans, pets and stock. Take care and remove these items.

Healthy products is our responsibility!

Foreign matter in raw material is unacceptable.

Demonstrating & Trialing of an Internet-of-Things Solution For Real-Time Computation And Delivery of KPIs

Project 2017.1003

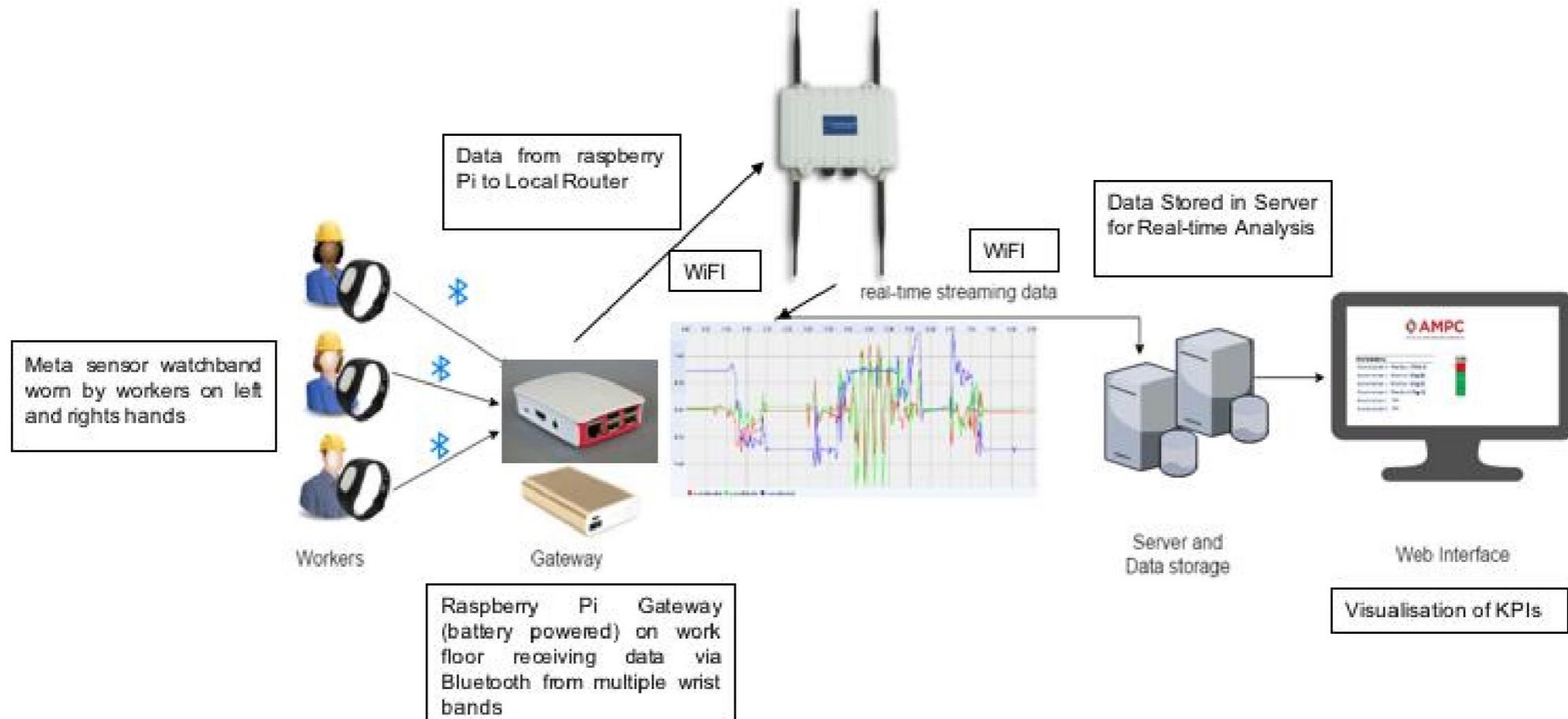
Gareth Forde

Principal Engineer, All Energy Pty Ltd

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W: allenergypl.com.au

Internet-of-Things Trial Architecture





(a)



(b)

Figure 2: (a) IIoT Meta sensor (Watch Device) worn under protective mesh glove (b) Images from Pre-trial conducted at AMPC Industry Partner Plant

Example of findings when you start analysing the data...

	Worker 1 (Experienced)	Worker 2 (Inexperienced)
Idle Time	36%	8%
Productive Time	63%	91%
Alignment Time	1%	1%
Active States	49	30

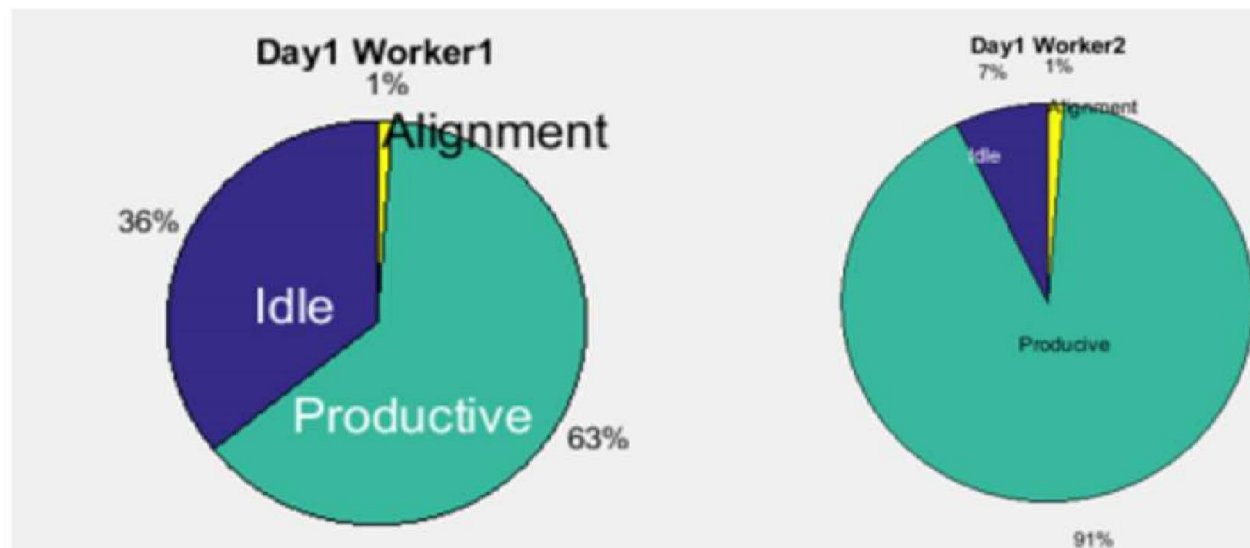


Figure 2: Sample output from IIoT in-plant trial showing that an experienced worker takes 31% less time (i.e. has less “Productive” time) whilst completing 63% more throughput (i.e. as indicated by the number of “Active States”).

PAYBACK: 0.2 to 0.4 years due to:

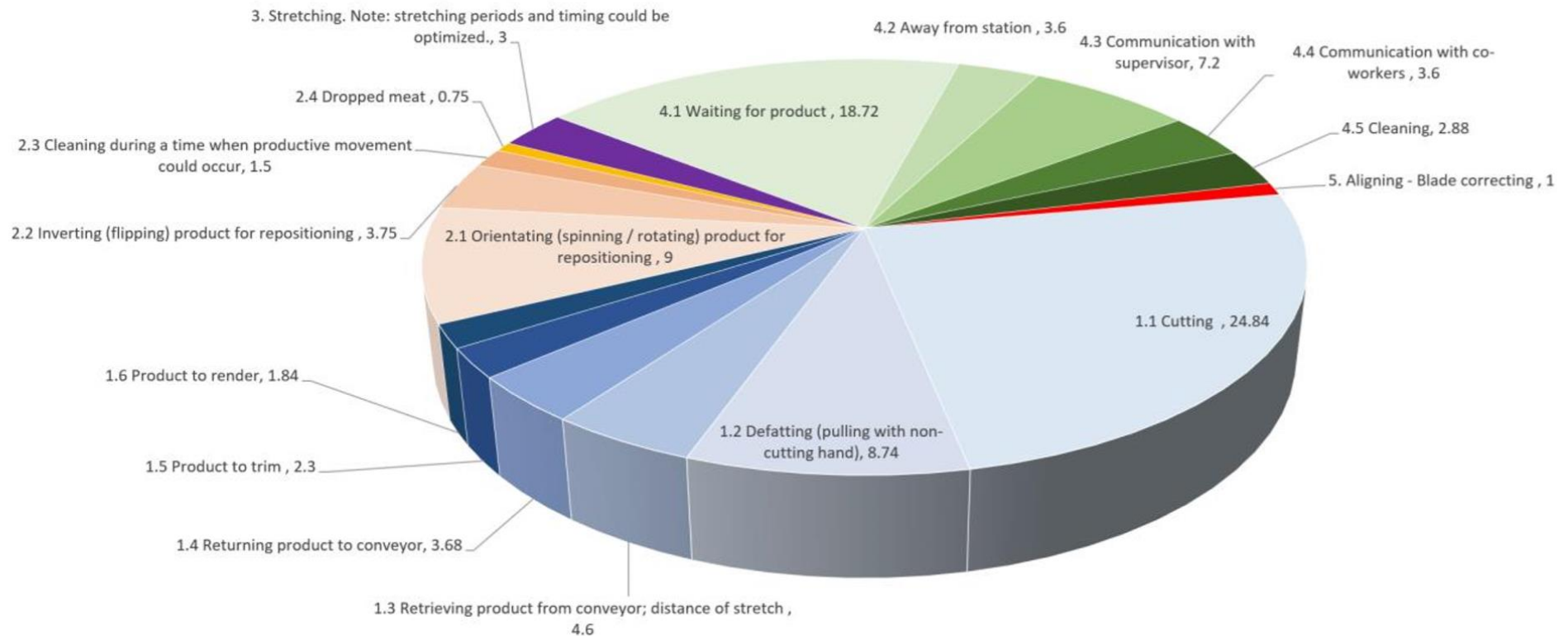
- Reduced soft tissue injury
- Higher throughput per unit time

Other benefits:

- 66% less knife movements; where 52% of knives are unsatisfactorily sharp
- Improvement in yield
- Average worker 24% less productive than an experienced worker
- Reduced supervisor movements
- Real time anomaly correction e.g. reduced claims and rework; automated increase / improvement in product availability to idle operators.
- Reduced training hours / automated training

HYPOTHETICAL Future Goal:

The following figure provides a **HYPOTHICAL** time split into 17 different activities that may be able to be achieved with a sufficient amount of data and analysis system training based on the actual Productive (shaded blue, orange and purple), Idle (shaded green), and Alignment (shaded red data) data for an experienced worker.





Additional information / input on:

- Ad hoc client / offtaker requirements not in the standard.
- Tallow and meal samples.
- Interest in mechanical separation or new devices.
- Any other feedback.

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