



final report

Project code: V.RMH.0073

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Date published: 25 June 2018, submitted to Michael Lee (MLA)

PUBLISHED BY
Meat and Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

Investigation of Novel Drying Technologies and Opportunity Spaces for the Australian Meat Industry

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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Executive summary

This report outlines findings from a thorough review of drying technologies, for their potential use in drying meats. Following this review, a market analysis was performed to determine the potential impact of a dried meat product on both the dried meat products market and the snack foods market. Following this review, several investigations were performed into mega-trends and opportunity spaces, to uncover the spaces in which dried meat products may have an opportunity. Finally, a series of design-led thinking workshops were conducted to investigate the dried meat opportunity from many perspectives. These workshops uncovered several additional opportunity spaces, which may be pursued in future projects.

The findings of the technological assessment were as follows:

1. The majority of new drying processes are not applicable to meat
2. Microwave vacuum drying may merit further investigation, in partnership with JBS
3. The current ways in which dried products are currently produced (tray drying and freeze drying) are unlikely to be disrupted, except perhaps by microwave vacuum drying.

The findings of the market assessment were as follows:

1. Dried meat and other snacks make up a very small segment of the snack market
2. The best way for dried meat snacks to increase market share, is not to try to expand the jerky market share, but to expand into the market of other snacks under another name entirely

The primary findings were as follows:

1. The consumer is disappointed with the sensory experience of jerky
2. There is potential to reinvent jerky, to deliver the experience the consumer is looking for and capture a much broader market. This could have the effect of posing a legitimate threat to the potato chip.
3. There is opportunity to explore dried meat as a flavour additive for chefs, either as a soil, sprinkle or crumble. This product could be sold at a high price and, if sufficient demand were generated, it could be highly successful.
4. The opportunity exists to develop a meat-based flavour additive with one of the international flavour houses. This product would cost more than conventional flavours, according to the way they are developed currently. However, this would allow the producer to label their product as 'flavoured with meat' as opposed to 'flavoured with artificial flavours'.

It is recommended that the following projects be conducted, to gain true value from the findings of this report:

1. Form an industry partnership with an international flavour house: the opportunity for dried meat as a flavour product.
2. Form industry partnerships with Australian chefs: the opportunity to use dried meat as a luxury ingredient for cooking.

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3. The redevelopment of Jerky: project with a large food producer. The main objective of this project would be to create the meat snack that delivers the outcomes consumers are really looking for—one which provides protein at snack time.

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1. Project overview

It is stated in the terms of reference (TOR), to which this document responds, that the Australian red meat industry is mostly reliant on commodity-based products. To stay competitive on a global scale, the red meat industry needs to capture value, by diversifying into a range of non-commodity (value-added) products.

To this end, Meat and Livestock Australia has commissioned a series of investigations into unlocking high value products for the red meat industry. These investigations are focused on opportunity spaces identified by MLA, one of which is dried meat.

The global mega-trends of eating while on the move, snacking and health-conscious eating, all suggest, in combination with technological advances, that dried meat will be a growth sector in years to come. If these mega-trends can be harnessed and used to aid the growth of the Australian red meat industry, it will ensure a leading market position in the future.

This investigation focuses on ways to capture market growth and position for dried meat products. Opportunities shall be investigated through a design-led thinking approach, whereby the initial question asked is “what do the people want?”. Following this, the process empathetically determines the client’s wants and needs. Once the customer’s wants and needs are uncovered, the design-led process works back through the supply chain, to find a way to provide those products in a way the customer finds value.

In this case, the design-led thinking approach will look at the following specific topics:

1. Consumer desirability – will people buy it?
2. Technical feasibility – can the product be made?
3. Commercial viability – can the product be produced and sold for a profit?

The investigation is performed in two parts: desktop research and design-led thinking workshops.

The desktop research section is aimed at identifying and evaluating technologies and markets where Australian dried red meat products may expand.

The research section reviews the following technologies:

1. Tray drying
2. Vacuum microwave drying
3. Drum drying
4. Extrusion porosification drying
5. Spray drying
6. Evolum belt drying
7. Freeze drying
8. Dehumidifier tray drying
9. Thin-film belt drying
10. Flash dry processes
11. Osmotic vacuum drying
12. Anhydro spin flash drying
13. Microwave tumble drying
14. Vacuum tumble drying

In addition to these technologies, the investigation encompasses a variety of cultures and regions where there is a market for dried meat. Furthermore, several dried food case study products are examined. These case studies are intended to highlight what makes a successful product in the dried food industry,

without necessarily being dried meat, with a view to expanding meat products into this space in the future.

The second section of the investigation is the design-led thinking workshops. These workshops were led by Wiley's design-thinking team and were aimed at uncovering opportunities in the Australian dried meat snack market.

The workshops gathered people from the following interest groups:

- Food retailers and supermarkets
- Small-scale meat snack producers
- Industry peak body representatives
- Food science experts
- Food marketing experts

Two design thinking workshops were undertaken with these stakeholders, and the findings are outlined in detail in the design-led thinking section of this report.

2. Objectives

The project was comprised of two elements—a research project and a design-led thinking workshop. The objectives of these two investigations were as follows:

2.1 Research component objectives

- Undertake a high-level investigation of drying technologies in terms of what is produced, the typical input material, the value-add of these products and any potential to adapt to drying meat.
- Identify promising technologies and undertake a more detailed technical review (3-5 technologies).
- Investigate the commercial viability of the different products, in terms of what generates value. Cost structures may be apparent, given these applications.
- Investigate the consumer desirability, including the global trends in terms of meat consumption and the socio-economic trends.
- Uncover major opportunity spaces which Australian red meat can take advantage of in the future.

2.2 Design-led thinking workshops

- Use the information gathered in the research component of the investigation to inform the design-led thinking process.
- Bring together industry representatives to reduce blind spots and increase originality.
- Uncover opportunity spaces for the Australian dried red meat industry, using collective knowledge, experience and original workshop activities.

3. Technical market assessment

This section shall discuss several drying technologies including their typical applications, technological readiness and providers.

3.1 Drying technologies

An investigation into new and improved drying techniques has the potential to yield new opportunities for MLA member companies to significantly increase revenue. The UN Food and Agriculture Organisation recommends that beef (and buffalo) meat is the meat best-suited to being dried. This is due to its relatively low levels of intermuscular and intramuscular fat.

Drying mostly preserves the nutritional content of meat and increases its shelf life, making it a useful process for exporting new and improved products. (United Nations Food and Agriculture Organisation, 2017). Given these traits, and the widespread nature of existing dried meat products worldwide such as jerky, mince and feed; the dried meat market has worldwide revenue opportunities which may be exploited by producing new products with new technologies.

A dryer is, broadly, a machine which removes water from a product. Dryers differ based on their mechanisms of heating and vapour transport. Two main categories of dryers are: *in-gas* (i.e. in air, nitrogen etc.) or *in-vacuum*. Air drying is less complex and therefore more common. Alternatively, vacuum drying is useful for when low temperatures are required, such as when foodstuffs are delicate or micro-organisms are to be preserved rather than killed (e.g. cheeses) (X.D. Chen, 2009).

The MLA's Terms of Reference regarding the scoping of emerging drying technology, included twelve (12) different meat drying techniques. Two other technologies (microwave tumble drying and microwave vacuum drying) have been added in the interest of completeness. Desktop research has been conducted into each of these techniques (several of which are in fact closely related), with the key findings for each technique presented below, along with recommendations regarding their potential for red meat applications.

3.1.1 Tray/dehumidifier tray/cabinet drying

Tray or cabinet drying is the most popular and widespread drying method for discrete meat products and is the technology used by most jerky manufacturers, including Geronimo jerky, a case study product.

The meat is placed in trays and heated via hot air, heated trays or heated shelves, and dried over many hours. This produces jerky and other familiar dried meats (United Nations Food and Agriculture Organisation, 2017). Due to the versatile nature of trays, multiple types of wet material can be dried using this method (NZ Institute of Food Science and Technology, 2017).

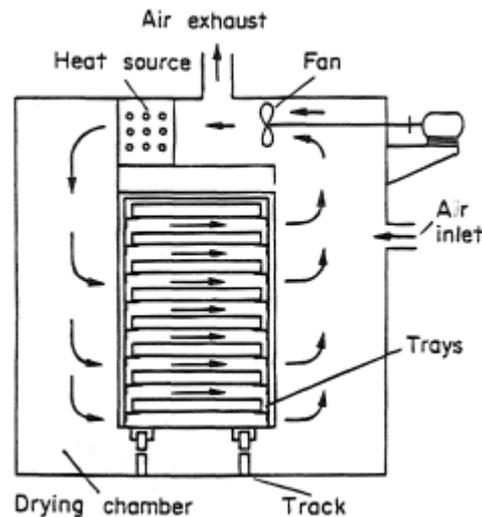


Fig. 1: Tray dryer (Mujumdar, 2015)

Operational process

The process of a standard tray dryer is very simple. Air currents, generated by a fan, pass through a heat source that increases the temperature of the air to approximately 60-70°C (United Nations Food and Agriculture Organisation, 2017).

The heated air then passes through the trays within the cabinet, extracting moisture from the drying product through the process of convection. Fresh air is frequently drawn into the system by the fan. The heated air (which has retained some of the moisture from the drying product) is passed out through an exhaust vent (Kodoori, 2017).

To avoid food safety standards being violated, it is critical that the moisture can leave the cabinet. Bacteria and mould can begin to grow on the meat, due to the warm and moist environment (Kodoori, 2017). The process is almost identical to the one demonstrated in the picture of a tray dryer in Fig. 1.

Applications

This drying technology is commonly applied to food products; ranging from fruit and nuts, to meat and fish (Kodoori, 2017). Common types include large, commercial cabinets for the production of jerky and powdered liquids. Small bench-top food dehydrators are used for homemade dried fruit and preserves.

Tray drying is also used for the drying of drug and chemical powders in the pharmaceutical industry (Kodoori, 2017). Meat products, such as beef or pork, shrink when dried, due to lack of moisture (Kodoori, 2017). The texture of the meat becomes hard and brittle and is very fibrous.

Fruit, vegetables and nuts also reduce in size when dried and often become misshapen and discoloured. The taste often remains the same, or at least similar to pre-drying, but the texture is frequently leathery. A variety of different dried fruits and nuts can be seen below in Fig. 3:



Fig. 3: Variety of dried fruits and nuts (James, 2017)

The last major product produced by tray drying are powders, which are often processed from liquids. For example, milk can be dehydrated to produce milk powder. This powder can then be used in baby formula, cake mixes and other products, to help preserve the product for future use (FDA, 2017). An image of powdered milk is shown below in Fig. 4.



Fig. 4: Powdered milk (Drevets, 2017)

Red meat applicability

Tray drying is the most common method for drying red meat. It is the most well-known technique in the industry, with mature and simple technology which is found in a clear majority of jerky production operations. While it is simple and reliable, its large energy consumption and low speed hinder the efficiency of the process.

Table 1: Tray drying overview

Input product	Discrete pieces (meat + products, fruit, veg), powders
Output product	Discrete solids, powders
Drying temperature range (°C)	60-70
Drying time/capacity	4-5 hours; up to 20,000kg/day capacity per machine
Current product applications	<ul style="list-style-type: none"> • Beef jerky • Dried fruits and nuts • Liquid powder • Pharmaceuticals
Manufacturers	Powder Systems Limited (United Kingdom) Drying Solutions (New Zealand)

3.1.2 Tunnel drying

Tunnel drying is a similar technology to tray/cabinet drying, but on a larger scale. Tunnel drying involves passing stacked trays or 'trucks' of wet material through one or more heated tunnels. Like tray drying, tunnel drying is applicable to multiple discrete solid materials, or even liquid material on solid trays. Airflow in the drying tunnel(s) may be parallel flow, counter-flow or combined flow. A dryer configuration may consist of a single tunnel or multiple tunnels, the latter at different temperatures to reduce product damage from high-heat exposure.

Red meat applicability

Similar to tray drying, tunnel drying is popular in the industry, but more commonly used for mass-drying. Tunnel drying results in a more efficient process of drying, as more finished product is produced in a similar time frame, but the construction, energy and maintenance costs are much greater.

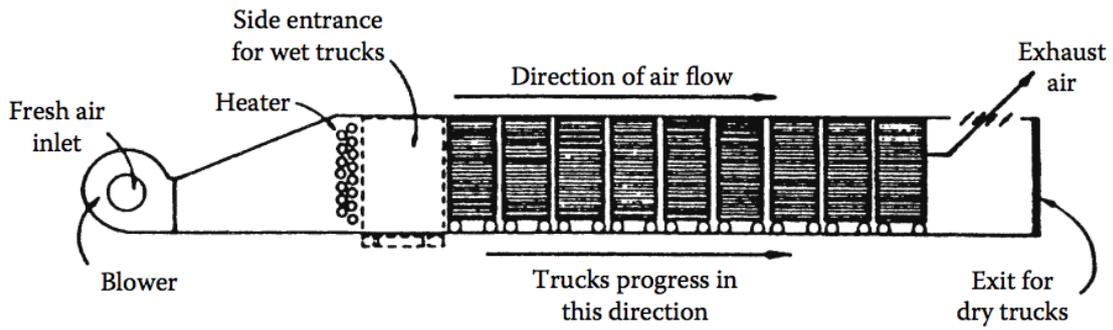


Fig. 5: Tunnel dryer (Mujumdar, 2015)

Table 2: Tunnel drying overview

Input product	Discrete pieces (meat + products, fruit, veg), powders, liquids
Output product	Discrete solids, powders, residue
Drying temperature range (°C)	99-104 'wet' tunnel; 65-71 'dry' tunnel
Drying time/capacity	Dependent on tray height, tunnel length, number of tunnels and type of product (6 – 72 hrs)
Current product applications	Beef jerky
Manufacturers	Wyma (New Zealand)

3.1.3 Drum drying

With drum drying, one or two hot drums are slowly rotated as liquid or semi-liquid material is fed onto the exterior. The drums are heated either internally or externally, and rotated through approximately 300°C before the dried product is scraped off by blades and collected in troughs (Mujumdar, 2015). This technology has been around for a long time and is regarded as inefficient and superseded.

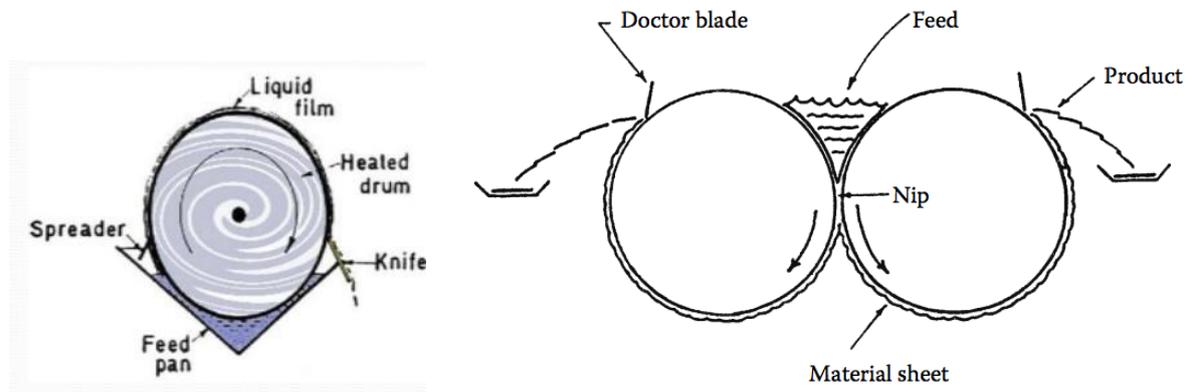


Fig. 6 and 7: Single (left) and double (right) drum dryers (Mujumdar, 2015)

Red meat applicability

As drum drying can only be used on liquids, its applicability to red meat is limited. Notably, drum drying can be used to dry cow's blood into blood flakes, a product which can be used to supplement diets or provide protein in animal feed. Unfortunately, the market may not be significant.

Table 3: Drum drying overview

Input product	Powder/granules, slurry, liquid
Output product	Desiccated powder (moisture-free powder)
Drying temperature range (°C)	200 (Tang, et al., 2003)
Drying time	5-24 seconds (Tang, et al., 2003)
Current product applications	<ul style="list-style-type: none"> • Bakery items • Pet food products • Nutritional supplements • Cereals • Snack items (Van Drunen Farms, 2018)
Manufacturers	Andritz Gouda (Netherlands) Atlas Copco (Australia)

3.1.4 Spray drying

A nozzle atomizes a liquid and suspends it into heated air, which is then injected into a chamber. The particles dry, leaving a fine powder of dried material, which is then extracted and exhaust air removed. Spray dryers can only be used for liquids, and typically use one of two heating methods:

- Direct air heating—which is efficient, but risks contamination from the heating fuels; or
- Air heating—via a heat exchanger, which is less efficient but fully sealed (Mujumdar, 2015).

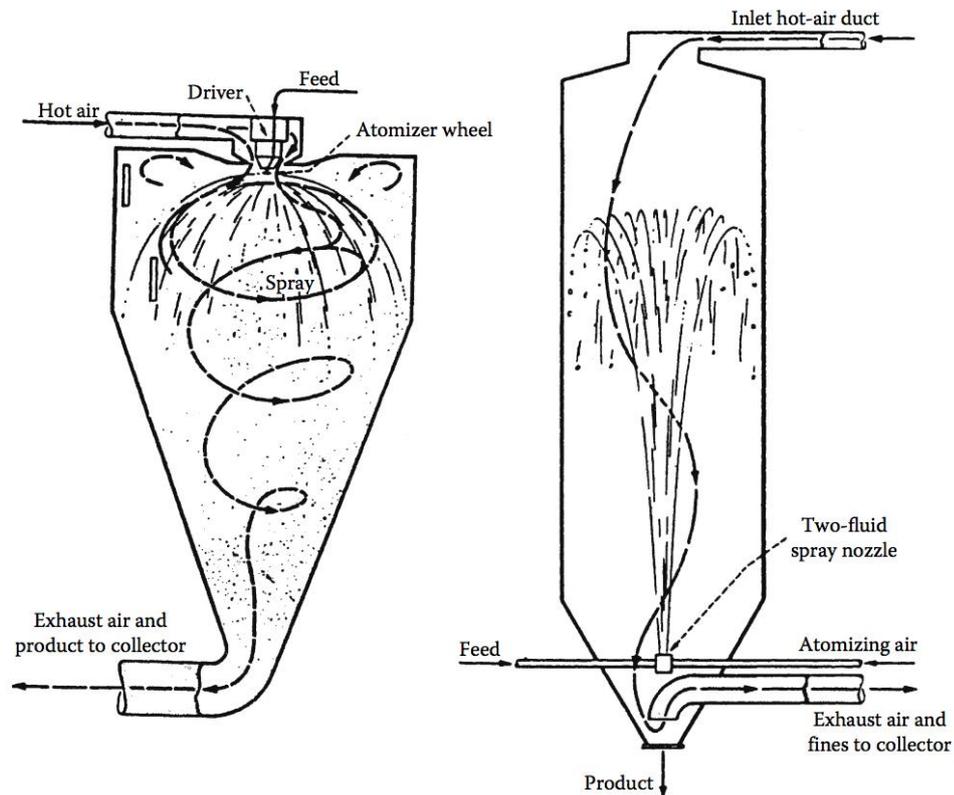


Fig. 8: Spray dryer: drying chamber (left) and cyclone (right) (Mujumdar, 2015)

Red meat applicability

Spray drying requires the substance to pass through an atomizing nozzle. This implies that the material must be a low-viscosity liquid. This is not the case for meat and, in most cases, neither is it the case for blood. This means spray drying is not applicable to red meat.

Table 4: Spray drying overview

Input product	Smooth slurry, liquid
Output product	Desiccated powder
Drying temperature range (°C)	200
Drying time	Instantaneous
Current product applications	<ul style="list-style-type: none"> • Milk • Coffee • Tea • Egg • Enzymes • Whey protein • Fruits • Vegetables extracts • Ceramic materials • Dyes • Detergents <p>(Hasheminya & Dehghannya, 2013)</p>
Manufacturers	European Spraydry Technology (Europe) Spray Drying Systems (USA)

3.1.5 Freeze drying

Freeze drying, or lyophilisation, consists of two stages:

- The solid material is cooled to sub-zero temperatures; then
- It is placed in a vacuum environment, which allows the frozen water content to evaporate directly from the material, due to sublimation.

This produces a product that is very similar to its pre-dried state, but is now lighter and has an extremely long shelf-life. Freeze drying is complex, energy-intensive and expensive, and is therefore best suited to high-value foodstuffs such as dried meat and coffee (Mujumdar, 2015).



Fig. 9: Freeze drying (Harvest Right, 2016)

Operational process

The freeze-drying process relies exclusively on the property of the sublimation, which is the process of a solid turning directly into a gas (Harris, 2017).

At atmospheric pressure, water can occur in all three phases. As the temperature increases or decreases, it must transition to a liquid, before it can become a solid or a gas. If the pressure is lowered below atmospheric pressure to approximately 0.6Kpa, ice can no longer transition into liquid water at its melting point of 0°C. Instead sublimation occurs, and the ice turns directly into water vapour (Harris, 2017). The process can be more easily understood from the phase diagram shown below in Fig. 10.

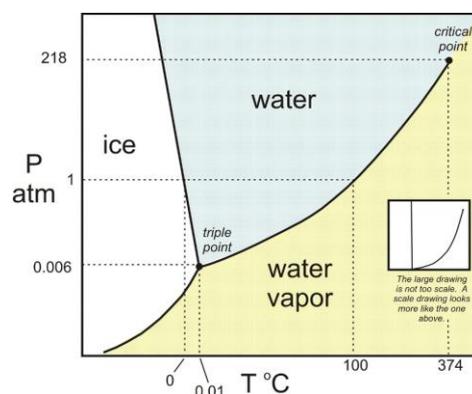


Fig. 10: Phase diagram of water (N., 2017)

The way the process occurs in a freeze dryer is very simple. The products to be dried are loaded into a shelved unit, designed to withstand the force of a near-vacuum environment (Harris, 2017). This unit is adjoined to a refrigeration unit, with a compressor and vacuum pump attached. After the product is loaded, the compressor is turned on and then product is cooled to below 0°C where it is frozen (Harris, 2017).

The vacuum pump is then activated, and the housing unit is then evacuated until the pressure is below 0.6kPa (Harris, 2017). The sublimation process then occurs, and the ice is turned directly to a vapour, causing the product to dry. The advantage of freeze drying, is that it dries the product without deforming the product like other drying processes. (Harris, 2017).

Applications

The main benefit of freeze drying, as opposed to tray drying or another drying technology, is that it leaves the molecular composition of the dried product almost unchanged (Harris, 2017).

In tray drying, the hot air causes the molecular composition of the product to change, due to the heat energy added to the molecules. However, for freeze drying, no heat is involved, therefore the molecular composition remains the same. This means if a product is freeze dried and then rehydrated later, the product will be almost indistinguishable from before it was dried (Harris, 2017).

Some common products that utilise freeze drying technologies are food products such as meats, fruits and ready-to-eat freeze dried meals. Shown below in Fig. 11 is a comparison image of a freeze-dried meal of spaghetti and meat balls, compared to the same meal after the addition of hot water.



Fig. 11: Freeze-dried spaghetti vs same meal with hot water (Harris, 2017)

Freeze dried foods often keep their shape and texture much more effectively than tray dried foods. Fig. 12 depicts pieces of two diverse types of banana—one that has been tray dried on the right and one that has been freeze dried on the left.



Fig. 12: Tray dried banana vs freeze dried (Howard, 2016)

Red meat applicability

Freeze drying is one of the more popular technologies, in terms of application to the red meat industry. It is already used to prepare meat for long-term storage and travel.

The principal challenge associated with this technology is the expense of drying. With the typical cost of freeze dried meat being approximately \$100/kg, this approach is too expensive to be used for mass production. Whilst jerky produced by other methods retails for similar prices, freeze-drying results in a jerky with less-intense flavour and subsequently, reduced marketability.

Table 5: Freeze drying overview

Input product	High-value products: meat, fish, chicken, coffee
Output product	As above, dehydrated
Drying temperature range (°C)	<0
Drying time	20-40 hours (Harvest Right, 2016)
Current product applications	<ul style="list-style-type: none"> • Meats • Fruits • Ready to eat freeze dried meals
Manufacturers	HarvestRight (USA) Freeze Dry Industries (Qld based, services + equipment)

3.1.6 Thin-film belt drying

Wet product is spread evenly by a dosing system over a conveyor belt, before being slowly fed through a heater where heated air/gas dries it at controlled temperature. Some belt dryer models are fully sealed, enabling pressure control for sensitive foods. Furthermore, belt dryers may also be inclined at angles of 15-20° to facilitate the unloading of dried material. (Mujumdar, 2015) (NZ Institute of Food Science and Technology, 2017)

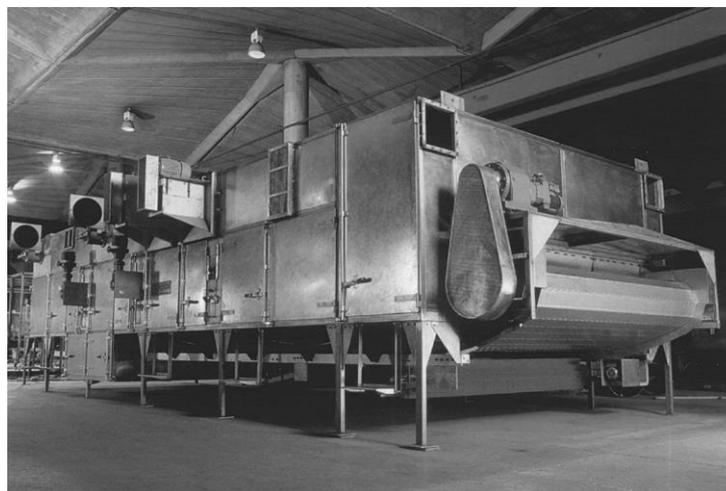


Fig. 13: An image of a thin-film belt dryer (Mujumdar, 2015)

Red meat applicability

Thin film belt drying is typically used for industrial quantities of biomass or liquids. It is not particularly well suited to drying meat, especially as it dries liquids. One could conceivably adapt the technology to accommodate solids, however, this would result in tunnel drying. Thus, the applications of thin film drying are limited for red meats.

Table 6: Thin-film belt dryer overview

Input product	discrete items or slurry/liquids in trays, uniform size
Output product	Dried items, flakes, powders
Drying temperature range (°C)	<300
Capacity	300kg/h
Current product applications	Cut vegetables
Manufacturers	Clextral (France)

3.1.7 Vacuum drying technologies

Vacuum drying is generally a secondary/complementary drying method, used in conjunction with a primary convection-based drying method. This is chiefly due to the excessive costs of vacuum drying, which are comparable with freeze drying.

A vacuum lowers the boiling point of water, allowing for easier and more comprehensive moisture extraction, which can be finely-customised to the product in question.

Mujumdar (2015) notes that, “moisture content of high-moisture food is typically reduced to 20%–25% by a conventional method, such as hot air drying, before a vacuum is applied to bring the moisture down to 1%–3%.”

Advantages of vacuum drying include minimal product losses, less mechanical stress, better flavour and better nutrient retention (Puschner, 2018).

3.1.7.1 Osmotic vacuum drying

Osmosis refers to the movement of a solvent through a semi-permeable membrane to an area of lower concentration. In a food drying context, it is possible to immerse a product in a solution which removes a substantial proportion of the product’s water content. This will not produce a product which is shelf stable, thus osmosis (especially in combination with vacuum drying) is suggested as a pre-treatment to other processes.

Red meat applicability

This technology can be used as a precursor to another process in the drying of meat. This can lead to reduced cost and potentially a more effective meat drying operation.

Table 7: Osmotic vacuum drying overview

Input product	High-value foods, fruit, vegetables
Output product	As above, minor change to state
Drying temperature range (°C)	N/A
Current product applications	As above

3.1.7.2 Vacuum microwave drying

This is a technology that is often seen in laboratories dealing with chemicals and non-organic materials. It appears possible, however, to use it in the process of drying foods. The machine acts as a microwave, heating the food from the inside out and evaporating most of its moisture content.

It is said that this produces better flavours with a higher nutritional content, that cannot be achieved by current drying machinery. However, it is an innovative technology in this industry and there exists very little prior art in drying foods.

Microwave drying is useful for killing micro-organisms in food, due to the rapid increase in temperature. It is increasingly employed to dry pasta, due to the lack of surface cracking, which would otherwise be caused by convection heating. (Mujumdar, 2015)

Operational process

The microwave vacuum drying process is straight forward and takes advantage of the properties of water at different pressures, in order to achieve a desired rate of evaporation (Parikh, 2015). There are many different setups that can be used to perform microwave vacuum drying, but the one explained here is cabinet tray microwave vacuum drying (Parikh, 2015).

The product to be dried is laid out on trays and placed inside a cabinet, which is then evacuated to a near-vacuum state at approximately 6kPa (Saraswathi, 2016). This reduction in pressure reduces the boiling point of water to approximately 25-35°C and allows for the water inside the drying product to evaporate, with the addition of very little heat (Saraswathi, 2016). This is the reason vacuum drying techniques (not just vacuum microwave vacuum drying) are used for heat sensitive products (Parikh, 2015).

The drying product is then heated through the exposure of microwave radiation in the range of 300Ghz to 300Mhz, which penetrates deep into the product and is converted into molecular kinetic energy causing the product to heat (Parikh, 2015). The rate of drying can be adjusted by changing the temperature the product is heated to, with a maximum limit of 315°C for most vacuum dryers (Parikh, 2015).

Vacuum microwave drying is typically faster than conventional vacuum drying. Fig. 14 shows that microwave vacuum drying can dry products in as little as 45 minutes, as opposed to inert gas vacuum drying and regular vacuum drying, which takes approximately 90 and 105 minutes respectively (Parikh, 2015).

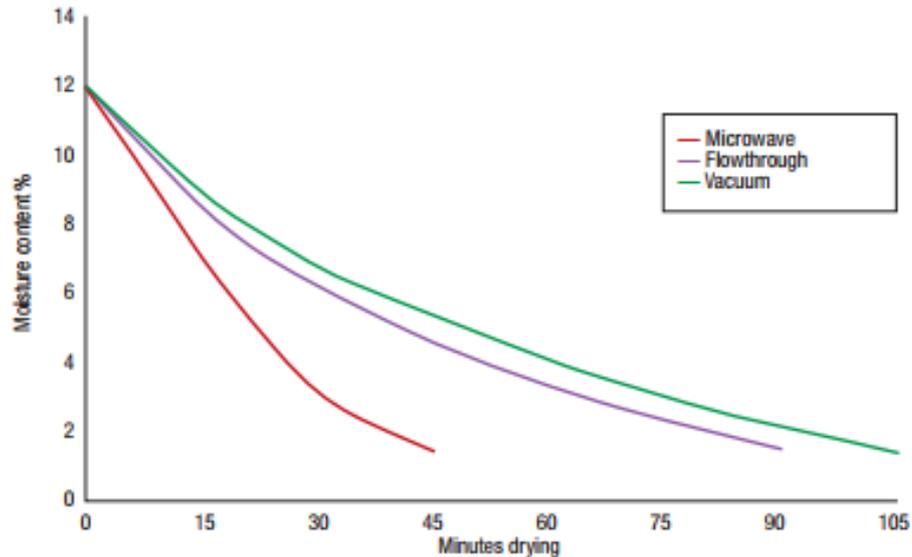


Fig. 14: Moisture content vs minutes drying for different processes (Parikh, 2015)

Applications

The main applications of microwave vacuum drying are currently not focused on the food industry. Instead, this drying technology is used primarily in the pharmaceutical industry to create powders and granules (Parikh, 2015). There has, however, been research conducted around the use of microwave vacuum drying in the food industry.

In a paper published in 1995, researchers used microwave vacuum drying to dry cranberries, to determine the effectiveness of the technology (Yongsawatdigul & Gunasekaran, 1995). It was found that the quality of cranberries, dried with microwave vacuum drying, was higher than those dried using conventional hot air drying. The researchers also determined that there was no significant difference in the impact on shelf-life between the two drying methods (Yongsawatdigul & Gunasekaran, 1995).

In a journal published in 2009, another study was conducted on the effects of microwave vacuum drying on mint leaves, compared again with conventional hot air drying (Parikh, 2015). The scope of this study was smaller, with the primary focus being on the colour of the leaves. The study found that mint leaves dried through microwave vacuum drying were light green to yellow, whereas the mint leaves subjected to regular hot air drying were brown in colour (Parikh, 2015).

Due to the increased activity of research into this technology for applications in the food industry, it should be monitored for continued improvement as it appears to be a promising technology.

Red meat applicability

This technology is potentially well suited to drying meat. With the low energy intensity and fast drying, this approach may be an effective alternative to tray drying. The primary challenges to the adoption of this technology are the taste of the product and the cost of setup. There is some uncertainty around how the product will taste and until this is resolved, and microwave dried jerky is tested, this technology

will not have a market. Additionally, given the newness and complexity of the technology, it is likely to be more expensive to set up than tray drying solutions.

Table 8: Microwave vacuum drying overview

Input product	High-value foods
Output product	As above, little change to physical state
Drying temperature range (°C)	Typically, 35-60, maximum of 315
Drying time	~45minutes (Celleme, 2013) (Parikh, 2015)
Current product applications	Fruit and vegetables
Manufacturer	ENwave (Canada)

3.1.8 Extrusion Porosification Drying (EPT)

EPT is a new technology currently being developed by Clextral, in conjunction with the CSIRO and Inovo.

It is very similar in nature to the current technology of spray drying, with the main difference being that EPT first runs the slurry through a twin-screw extruder, altering the texture and viscosity of the powder.

The mechanical shearing action helps to reduce the amount of drying heat required and, in turn, the energy required by the whole process. The products created by this process are high-value powders that can be reconstituted with the addition of water (such as dairy products, protein powders and microbial products). Whilst not yet a mature technology, EPT is marketed as a more energy-efficient alternative to freeze and spray drying, with claimed energy savings of 20-40%, compared to the latter process (Clextral, 2018).

Red meat applicability

Given that this technology is essentially spray drying made more efficient, there is little scope to apply EPD to meat products. Certainly, this application would be limited to blood products, as is the case for spray drying.

Table 9: Extrusion porosification drying overview

Input product	High-value dairy, protein, chemical products
Output product	Readily reconstituted powders
Drying temperature range (°C)	Not available
Capacity	30-50 kg/h
Current product applications	Fruit and vegetables
Manufacturer	Clextral (France)

3.1.9 Flash drying/Anhydro Flash Drying

Flash drying is designed for particulate, viscous or slurry material. Extremely hot air (650°C) is mixed with the input product, before being pumped into a low-pressure chamber. Airflow separates particles; increasing surface area and speeding drying. This process is efficient and large-scale, but is designed for granular and powdered products, making it unsuitable for large, discrete meat products.



Fig. 15: Flash dryer (SPX, 2012)

Red meat applicability

As with the rest of the non-solid drying technologies, this is less applicable to red meat products. This approach could be used for blood products; however, these products are more efficiently produced using drum drying.

Table 10: Flash dryer overview

Input product	Grain, vegetable, chemical products
Output product	Fine powder
Drying temperature range (°C)	~80-90
Capacity	Not available
Current product applications	As above
Manufacturer	GEA (Germany)

3.2 Recommendations

3.2.1 Candidate technologies

The most obvious and widely-used candidate technology for dried meat products is **tray drying**, and its larger-scale derivative, **tunnel drying**.

This process involves large quantities, flexibility of input products (size, shape, viscosity) and finely-controllable parameters such as temperature and drying time. All of these attributes make this process suitable for dried meats.

Newer, more specialised technologies which will likely be suitable, are **freeze drying** and **vacuum drying**. Mujumdar (2015) states that these two technologies are the most suitable methods for drying meat products, which is chiefly due to their relatively high cost, making them suitable to higher quality, value-added products such as meat.

Both freeze drying and tray drying are batch-based processes rather than continuous, making them more suited to discrete meat products. The lower thermal power delivery by both processes also makes them less likely to damage the product or reduce its nutritional content. More information on the above parameters can be found in the following tables:

Table 11 and 12: Product and recommended dryer type (Mujumdar, 2015), (Fenollosa, 2005)

Food and Feed Products and the Most Suitable Dryer Types

Product	Dryer Type
Vegetables, confectionery, fruits	Compartment and tunnel
Grass, grain, vegetables, fruits, nuts, breakfast cereals	Conveyor band
Grass, grain, apple, lactose, poultry manure, peat, starch	Rotary
Coffee, milk, tea, fruit purees	Spray
Milk, starch, predigested infant foods, soups, brewery, and distillery by-products	Film drum
Cereal grains	Moving or stationary packed beds
Starch, fruit pulp, distillery waste products, crops	Pneumatic
Coffee, essences, meat extracts, fruits, vegetables	Freeze and vacuum
Vegetables	Fluidized bed
Juices	Foam mat
Apples and some vegetables	Kiln

TABLE WITH PARAMETERS COMPARISON OF DRYERS

	Thermal power	Initial moisture	Final moisture	Evap. capacity	Type of process	Vacuum necessary
Fluid Bed	Med	5-50 %	0.1-5 %	5-1.000	Batch/ Continuo	Sí / No
Paddle dryer	Med	5-50 %	0.1-5 %	10-5000	Batch/ Continuo	Sí / No
Bicone	Low	5-50 %	ppm	10-100	Batch	Sí
Cone	Low	5-50 %	ppm	10-100	Batch	Sí
Spray dryer	High	20-98 %	0.1-5 %	10-10.000	Continuo	No
Tray dryer	Low	10-70 %	0.1-2 %	10-100	Batch	Sí
Flash dryer	High	5-98 %	0.1-1 %	10-10.000	Continuo	No
Turbulence dryer	High	5-80 %	0.1-1 %	10-5.000	Continuo	No
Liofilizer	Low	5-90 %	ppm	0.1-10	Batch	Sí

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The remaining drying technologies which were researched, are less suited to meat products, being designed to take in liquid, powder or slurry material, rather than discrete food items. However, there is potential for beef blood products to be processed using continuous drying methods.

Whilst pork blood (rather than beef) is the chief type of blood used for human delicacies, beef blood has potential applications as a high-protein animal feed supplement.

Viable drying technologies for beef blood include spray drying and drum drying (V Heuze, 2016)

4. Market opportunities and assessment

4.1 Summary and general trends

Currently, the global meat snack market has a 9% compound annual growth rate (CAGR) (Mordor intelligence, 2018) with a total value USD4.3 billion (Wood, 2017). According to PR newswire, the worldwide meat snacks market is estimated to exceed USD\$19.93 billion by 2025 (PR newswire, 2017). They also claim the market is poised to grow at a CAGR of 45.4%.

New approaches in marketing, developing a wide variety of flavours and targeting different consumers worldwide, are all expected to support market growth.

There exists significant growth potential for dried meat products (particularly jerky-style offerings) in **China, Japan, Europe** and the **USA** (Wood, 2017).

High income earners in China and Japan tend to purchase jerky. Whilst much of China is still focused on cheap, lower quality cuts due to accessibility, price and tradition. The growing middle class in China is driving increased demand for more premium meat products (Godfrey, 2014). As a product which can be sold in convenience stores and online, jerky is an attractive product for higher income earners looking to save time.

Within this market, Australian beef has an advantage, as it is perceived as high quality. Through targeting high income individuals and marketing high quality dried meat product, Australian meat may be able to capture a market.

Growth potential exists in Europe and Japan, where the market for jerky has been growing steadily over the past decade and with no clear market leader, offering the opportunity to Australian dried meat products.

Impending free trade agreements with Europe are set to increase the volume and decrease the costs of exporting Australian beef products to the EU. Japan's burgeoning jerky market is dominated by Australian company New World Foods—both in revenues and scale of distribution.

The US market is concentrated in the hands of several large companies, but the nation's world-leading demand for jerky (\$2.8 billion market in 2016), and high import volume of Australian beef, make it a potential growth market for unique, Australian-made products.

The following figure shows the world-wide snack market broken down into North America, Europe, Asia-pacific, Latin America and Middle East/ Africa.

These markets are shown by their preferred snacks in order, as well as the value of the market. The North American market for salty snacks is the largest in the world (at 28 billion USD). The second largest salty snack market in the world is Europe (at 24 billion USD) and Asia-pacific (at 9 billion USD).

THE BIGGEST SNACK CATEGORIES WORLDWIDE

RETAIL ANNUAL DOLLAR SALES ENDING MARCH 2014

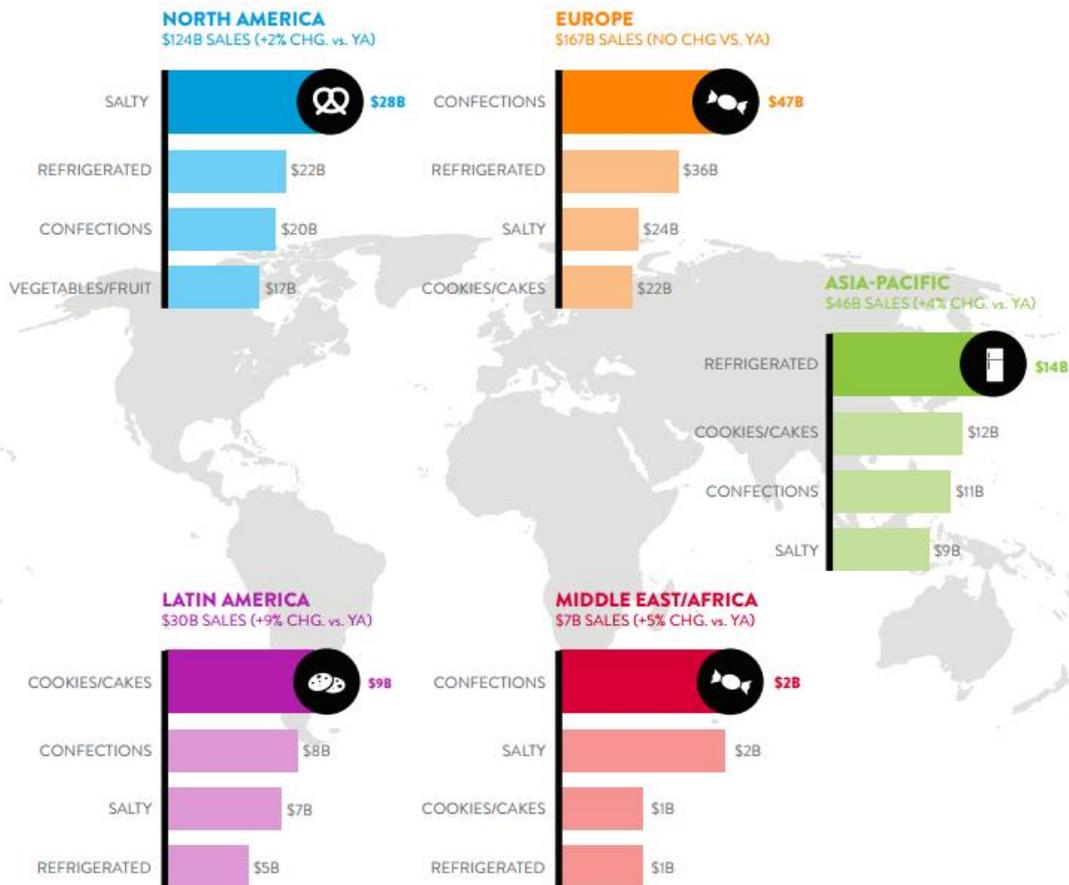


Fig. 16: Largest snack categories worldwide (Nielsen, 2014)

4.2 Investigation by country/region

4.2.1 Australia

According to leading intelligence agency Mintel, Australia is poised for a meat snacks revolution. With the US and the UK both achieving 50% growth in the sector from 2011 to 2016, Australia is situated for similar growth. Signs of this growth include many start-ups, as well as the fact that Australia has the fourth-largest paleo-friendly market on the planet (Minotto, 2017).

Additionally, Australia’s love of snack foods in general is projected to remain strong in 2018 (Food and drink business, 2017). According to the Australian Institute of Personal Trainers, 35% of Australia’s calories comes as discretionary eating (AIPT, 2017).

The Australian snack food market is estimated to be worth 3.3 billion AUD, with an average CAGR of 3.3% (HILL, 2017). If the Australian jerky market were to reach the same percentage of the snack food market as it is in the US or the UK, the jerky market would be worth up to \$108 million AUD. At present, it is estimated that Australia's jerky market is worth \$40 million AUD.

Case study: Geronimo Jerky

Process

Beef is introduced into the facility from a local source. Firstly, the fat is removed to ensure the jerky is of high quality meat. Next, the beef is turned into long strips using a stripping machine, making it easy to marinate in the different flavours. Geronimo has eight signature flavours—with six receiving a bronze award, and one receiving a silver, at the 2012 Sydney Royal Fine Food Show.

From the original jerky, to the spiciest Australian beef jerky (the Flamin' Arrow) and even a jerky that has Guarana as an ingredient—there is definitely a variety to choose from.

After being marinated, the beef undergoes a twelve-hour drying process that reduces the original 120kg of beef to just 40kg of dried meat, at a rough capacity of 10kg/hr. The dried meat is then sliced into bite-size pieces and stored inside jars, packets and bags, which are then sold to customers.

They sell 40g packets for approximately \$6, where the regular retail price for such a protein-rich and tasty jerky would be almost \$9 at regular retail store.

Although the store only gets approximately ten customers a day, they make most of their profit from selling jerky in bulk amounts to the army and selling online, shipping Australia wide.

Revenue

Between salaries, the cost of electricity and the cost of raw product, Geronimo has daily expenses in the order of \$3,000. For that cost, Geronimo produces \$6000 (40kg) worth of jerky from 140kg of raw beef. Thus, the annual income of Geronimo is approximately \$2 million, with costs of \$1 million.

Expansion

It can be expected that Geronimo are wishing to develop a more efficient system that can produce more finished product daily. The weak link in this process is the drying of the meat.

Currently, Geronimo are using a dryer that is energy-intensive and time-consuming. The first step for expansion would be implementing a more efficient drying system. A vacuum microwave dryer, would reduce drying time to approximately thirty minutes. This is a significant reduction in processing time that would result in fewer working hours, more dried meat production and potentially an overall increase in profit. Short and long-term expenses must be considered. Without detailed information regarding the CAPEX of such a dryer, it is impossible to make more informed and dependable recommendations.

Geronimo have mentioned they are interested in expanding their business, but more importantly, they value the growth of jerky in Australia. Tim, the owner of the business, was continuously encouraging us to open our own store, or to try and create our own jerky. It appears the aim of the company is not to just expand their business, but to expand the entire industry.

4.2.2 China

China represents a significant opportunity for dried meat products due to the size of the market, the growing middle class with their appetites for premium food products, and the nation's high regard for Australian beef.

Due to the low cost and versatility of pork and chicken, beef has never been a large part of the average Chinese diet. However, with changing trading laws and more consumers able to afford beef, the red meat is increasing in popularity, due to its nutritional benefits and variance from traditional meats (Meat and Livestock Australia, 2015).

4.2.2.1 Current market

China is predominantly a market for lower-value beef products, as evidenced by the composition of Australian beef exports to China. Brisket, shank and silverside, either chilled or frozen, make up the top four most popular cuts of beef exported to China in 2015 (Meat and Livestock Australia, 2015).

In 2014, 99% of the total beef imports were frozen and worth US\$4.30/kg on average. The remaining one percent was either fresh or chilled beef. This was previously sold for US\$18/kg in 2011, but in 2014 was reduced to just US\$7.20. This decrease signals that demand for all imports of beef is price-sensitive and that a large amount will be used for processing or low-value mass-market appeal (Edwards, et al., 2016).

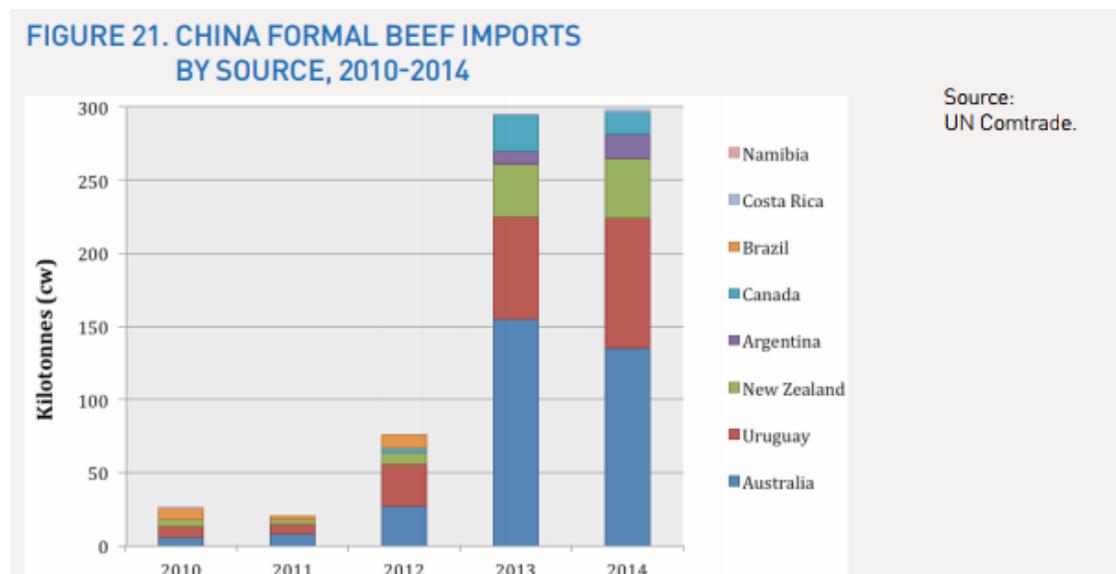


Fig. 17: China formal beef exports (Edwards, et al., 2016)

Despite this appetite for lower value beef cuts, there is growing demand for more premium beef products.

The wealthier, urban middle-class of China have the most desire for safe, quality food. They also have the money and willingness to pay more. This group of people, who earn disposable incomes of at least AUD\$50,000, are the ones that can afford and love to buy Australian imported beef. Furthermore, Australian beef is seen as high quality and is viewed as the world's best performer in a number of

important qualitative metrics, such as taste, willingness to pay more, and perceived superiority (Meat and Livestock Australia, 2015).

4.2.2.2 Distribution

Since 2011, online sales have doubled every year. 16% of total retail sales in 2015 was due to the rapid growth of E-commerce, particularly in food sales. This is expected to grow to as much as 30% by 2018. Yet, approximately 40% of total online sales involve imported goods.

Almost half of China's 1.4 billion population are internet-connected, with a quarter of the population having bought groceries online in 2015 (Meat & Livestock Australia, 2016).

Sino-Australian Top Beef is an online Chinese beef market that could soon be the owner of tonnes of Territorian produce. Their website sold 4,000 tonnes of premium steak last year, and they are looking to expand to include high-quality beef jerky in their sales, with a large market expected to be patiently waiting (Dunlop, 2016).

4.2.2.3 Dried meat opportunities

About 15% of China's meat is processed into meat products, dried meat being very popular. Approximately 95% of this dried meat produced in China is made into Bakkwa (also called bakkwa or rougan), a salty-sweet dried meat product similar to jerky. Given its popularity, this would be the principal dried meat product to produce for the Chinese market (Gould, 1995).

Live cattle and meat can be difficult to import to China, whereas beef jerky is a long-lasting product that is easier to import and faces less scrutiny from the Chinese government.

With Chinese red meat consumption expected to grow consistently to 2020, it is expected a sizeable market for jerky will develop in this country (Dunlop, 2016).

With young, wealthy Chinese consumers wanting to save time eating, the demand for beef products that are convenient and fast is rising, with more processed beef products being bought. In this country, a rise in income usually comes with an increase in beef consumption, and more so a rise in consumption away from home. Generally, they are also willing to spend a modest premium in exchange for safer goods, yet demand that if more money is being spent, the food and meat should be of greater quality (Edwards, et al., 2016).

4.2.3 Taiwan

4.2.3.1 Market

Due to small land area and constraints on the capabilities of locals to produce beef, 96% of beef used for consumption purposes is imported to Taiwan. This country's beef consumption increased by 64% between 2004 and 2015. Specifically, young people showed an increased preference for beef products (US Commercial Service, 2017).

Australia is the second-largest beef exporter to Taiwan, with 27% market share, behind the US on 47%. Having a clean and organic image, as well as high food standards, have contributed to Australian beef being well received in Taiwan. Australia, New Zealand and USA, together make up 94% of the market (AusTrade, 2017). Australian beef was originally cheaper than New Zealand and US beef, with more stability across market share, quality and price. However, New Zealand products have grown

significantly cheaper since the 2013 free trade agreement between the two countries, which meant that all New Zealand beef exports to Taiwan were tariff-free.

For the first quarter of 2016, the volume and value of beef imports increased by 5% and 4% overall respectively, yet Australia's import supply was steady on a year-to-year basis. To make up the difference, Taiwan increased volume and value from New Zealand (volume by 22% and value by 19%) and the USA (volume by 20%, value by 12%) (Meat and Livestock Australia, 2015). With tariff-free exports from New Zealand, and targeted value cuts from the USA, Australia will need to develop strategies to remain competitive in the market. Opportunities include:

- Gathering a better understanding of Chinese meat preparation, so new beef cuts can be introduced that match these techniques.
- Creating a long-term plan to increase the market, by addressing current issues such as the hesitation of retailers to commit to Australian beef, due to the shrinking margin of beef sales.
- Ensuring that advertisement of the nutritious, organic beef produced in Australia reaches the correct audiences, while exporters create strong public relations through the promotion of beef.

4.2.3.2 Dried meat opportunities

In 2013/14 when Australia was the leading importer to Taiwan, the most popular beef imports to Taiwan included knuckle, shank, rib finger and chuck tender. Although USA chuck is less expensive than Australian, the beef hadn't gained traction with jerky manufacturers in Taiwan like Australian chuck, which was heading for Taiwanese factories.

This is unlikely to remain the case. As New Zealand beef is far cheaper, it is conceivable that their chucks will be entering the small Taiwanese jerky factories more than Australian beef. Although there is a small market for jerky in Taiwan, and it is rather difficult to find, it is considered juicier and more flavoursome than some US jerky (Think food thoughts).

While their jerky is of a high standard, minimal interest has been generated amongst locals and the jerky created is often used for personal use or exported to other countries.

Overall, dried meat in Taiwan is unlikely to be a good opportunity space, as the jerky would be difficult to sell and manufacture.

4.2.4 Japan

4.2.4.1 Market

Japan is Australia's second-largest export market and the third-largest economy in the world. Japan has a sophisticated food market that provides opportunity for premium imported meat products (AusTrade, 2017).

23% of Australia's annual beef exports go to Japan, second only to the USA (28.6%), making it a very well-established market for new processed beef products (Farm Weekly, 2017). Japan's sweet and savoury snack market is worth 12 billion USD annually.

The imported meat snacks sector is worth about \$135 million USD, with 55% market share taken up by a single brand, Local Legends, owned by Australian company New World Foods. The Local Legends brand

targets the medium-premium to high-premium end of the market. Local Legends jerky is a softer, chewier product than most traditional jerky (Bryant, 2014).

4.2.4.2 Distribution

Japan has an extremely dense coverage of convenience stores and vending machines, both of which are well-suited to processed, premium products with long shelf-lives such as beef jerky.

There are also more unique distribution channels such as Japan's bullet train (Shinkansen), which serves approximately 400,000 customers daily and 150 million annually.

New World Foods' Mariani brand is the only beef jerky product sold on the bullet train, giving it an Australian-owned monopoly over a lucrative sub-market.

4.2.4.3 Dried meat opportunities

In 2015, the Japanese market was reopened to the USA processed beef products for the first time in 11 years. Products such as the USA brand 'Perky Jerky' were ready for local sale in a matter of weeks. The subsequent influx of USA jerky brands over the ensuing three years has likely stimulated Japanese demand for jerky products. Australian brands and manufacturers could tap into this demand.

Brian Levin, chairman of Perky Jerky, states the company has, "...been targeting its premium jerky products for the Japanese market, which has a very high rate of jerky consumption... we expect Japan to be a multi-million-dollar market for us in 2015 and beyond" (USDA, 2015).

4.2.4.4 Case study: New World Foods 'Local Legends' Beef Jerky

The snack market in Japan is estimated to be worth 12 billion AUD in sales annually, with the meat-based snack sector valued at \$135 Million AUD (Condon, 2014). These numbers alone indicate there is a growing demand in Japan for 'snack foods'.

New World Foods has recognised this trend and has been distributing its Mariani beef jerky range in Japan since 1987 (Condon, 2014). The company is responsible for the importation of approximately 55% of Japan's meat-based snacks (Bryant, 2015). A key to the success of their Mariani snack range has been the distribution channels they have secured.

Despite New World Foods' massive success with their Mariani product range, the company had no initial plans to launch their new Australian product 'Local Legends' beef jerky, until they were approached by a Japanese distributor who claimed that it was exactly what Japan needed (Bryant, 2015).

The launch of 'Local Legends' beef jerky has been a hit in Japan, with the product sold in the mid to high end supermarkets (Bryant, 2015). This success is promising for the cured and dried meats sector of Australia, as the 'Local Legends' product was not initially designed for the Japanese market, yet has been a success (Bryant, 2015). Such success is encouraging for other Australian brands, serving as a trailblazer for manufacturers of dried meats looking to break into the Japanese market.

4.2.5 Europe

4.2.5.1 Market

The European meat snacks market was estimated at \$1.94 billion USD in 2016 and is expected to reach approximately \$4.59 billion USD by 2025.

Germany accounts for the largest single share of this market, at 15.5%. The UK and Belgium, meanwhile, are expected to be the fastest-growing markets, with expected CAGRs of more than 10% up to 2025 (Grand View Research, 2017).

Australia was the fourth-largest supplier of beef to the EU in 2016, with a market share of 11%. South American countries dominate European beef supply; the largest supplier is Brazil, with 32% market share, followed by Uruguay (18%) and Argentina (16%). Current exporting of beef is hindered by the EU’s low-volume import quotas, and high-tariffs for exceeding these. However, it is expected that FTA negotiations between Australia and the EU will be concluded by 2020, paving the way for greatly-increased beef exports in the coming decade (Meat & Livestock Australia, 2016).

Germany meat snacks market revenue, by product, 2014 - 2025 (USD Million)

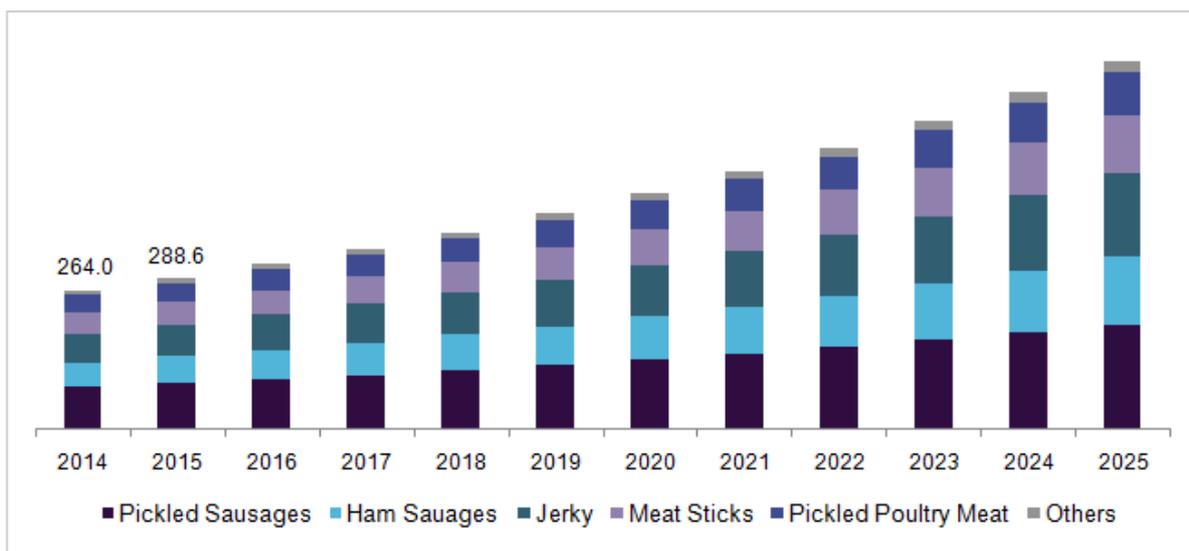


Fig. 18: Meat snacks revenue, projected growth (Grand View Research, 2017)

4.2.5.2 Distribution

Supermarkets were the largest single method of meat snacks distribution, accounting for 39% of meat snacks volume in 2016. Despite this, convenience stores saw the largest share of market revenues, accounting for more than a third of the market. Supermarkets were in second place, with approximately 26% of total market revenues.

The advantages of other distribution methods must also be considered. Online stores are increasing in popularity for products across all industries, with meat snacks being no exception, due to the convenience and lower prices when ordering online.

Smaller local grocery stores also accounted for more than 15% of market revenues in 2016, and their connotations of freshness and superior quality can be expected to drive more sales of dried meat products (Grand View Research, 2017).

4.2.5.3 Dried meat opportunities

The UK, France and other outlying parts of Europe have increased demand for meat sticks (jerky in particular). This is mainly due to the residents wishing to eat healthier, while still snacking. With Turkey and Russia also expected to be interested in Halal sticks, the demand for this snack type is expected to rise.

As mentioned above, the largest catalyst for increased beef exports from Australia to the EU will be the imminent FTA, with expected completion of late 2019. This will reduce or eliminate import tariffs on Australian beef, and likely increase or eliminate quotas, allowing Australian beef unprecedented market access.

When combined with an increasing demand for meat snacks, particularly in Germany, the UK, France and Benelux countries, Europe has the potential to be a significant growth market for Australian dried meat products.

4.2.6 USA

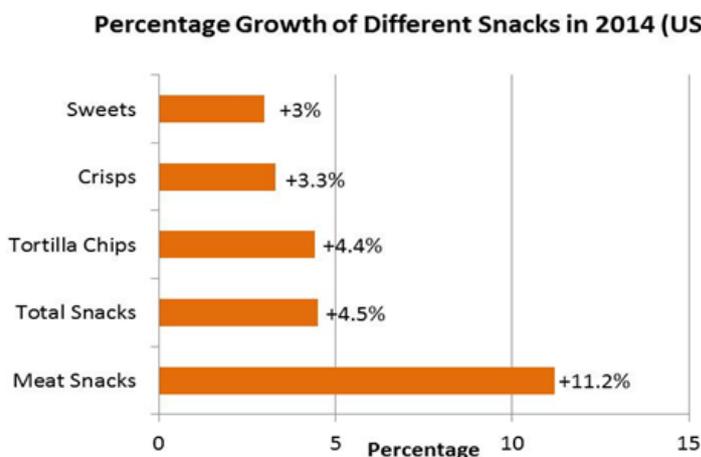
4.2.6.1 Market

Most imported beef in the USA is from Australia, and the largest single consumer of Australia's exported beef is the USA (28.6% of exports) (Farm Weekly, 2017).

The Nielsen Company estimates the total sale of meat snacks has grown 65% since 2003 and reached about \$1.2 billion USD in 2008, surged to \$1.58 billion USD in 2009 and continues to rise to almost \$2.5 billion USD in 2014 (The Nielsen Company LLC, 2014).

Despite this being only a small percentage of the massive \$374 billion USD annual snack market in the USA, the growth of meat snacks has already overtaken the growth of conventional snacks such as chips, nuts and chocolate (Ryan, 2015).

When it comes to meat products in the United States, jerky is king. Sales of jerky were \$2.8 billion USD nationwide in 2016, an increase of 46% since 2009. However, a recent report indicates that only 40% of USA households purchase meat snacks, suggesting there is room for greater market penetration (Brester, 2012).



Source: Nielsen

Fig. 19: Growth of snack sales in USA (Nielsen, 2014)

Statistics suggest the most common jerky consumers live in the western sector of the USA, and are typically males aged between 18 and 34, with earning between \$50,000 and \$70,000 (Brester, 2012). This constellation drove the jerky industry to hold the largest share (42%) of “other” snacks in 2015, with companies such as ‘Jack Link’s’ and ‘Slim Jim’ thriving on the success.

As displayed in Fig. 21, the “other” category barely compares to snacks such as potato and corn chips. However, if the growth of meat snacks as portrayed in Fig. 20 continues, this should not be a problem for the industry.

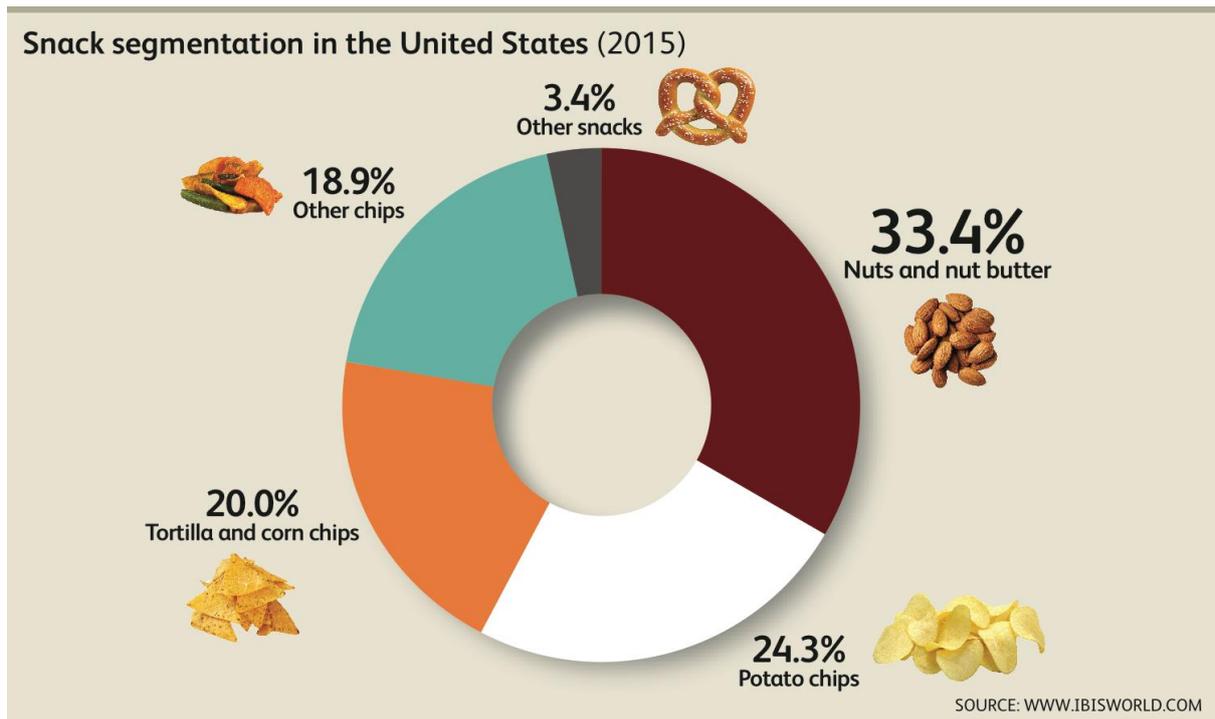


Fig. 20: Market segmentation of the USA snack market (McKay, 2015)

4.2.6.2 Distribution

Retail sales of meat snacks in convenience stores alone reached more than \$1.5 billion in 2016, a 3% year-on-year increase. Of these sales, roughly \$667 million USD were beef jerky products. Convenience stores account for more than 72% of sales, while grocery stores account for about 20% (Riell, 2016).

4.2.6.3 Dried meat opportunities

The market for meat snacks is worth \$2.5 billion in the USA, with an 18% increase in consumption among adults in the last 5 years (Ryan, 2015).

Meat snacks now rank number 4 in ‘the most popular savoury snack’ options, positioned behind only potato crisps, tortilla chips and nuts/trail mixes. The USA and South Africa are currently the biggest consumers of meat snacks, with the rest of the world remaining relatively under-developed.

Given the USA is currently Australia's largest beef export market, combined with the nation's world-leading appetite for jerky, there is significant opportunity for Australian companies to introduce dried meat products.

4.2.6.4 Case study: Epic Bar

EPIC Provisions is a company which has created a fully-cooked, meat-based bar containing fruit and nuts. The company was founded in 2013 and grew rapidly, reaching multi-million-dollar success in a small window of time.



Fig. 21: Epic Bars (Epic Provision, 2018)

Epic Bar is an excellent case study for well-targeted dried meat products. The combination of environmental-friendliness and nutritional-completeness can make an excellent product.

The company was sold to General Mills at an undisclosed price, but it is known the original founders kept their positions and that Epic Bars had sales close to \$20 million (Hughlett, 2016). This product shows that a convenient, well targeted and environmentally friendly product can be highly successful in the USA.

4.3 Key global market trends

Research into the field of global market trends in food and beverage, yields a very large number of differing opinions. Indeed, even professional research institutions such as Mordor Intelligence and Markets & Markets differ on their analysis of this complex topic.

Considering this complexity, this report shall feature perspectives on global trends according to the two most reputable sources available: New Nutrition Business and Mintrac. These perspectives shall be compared to give the reader an aggregate view of the global food and beverage trends, as well as how these trends apply to dried meat products.

4.3.1 As reported by New Nutrition business

4.3.1.1 Protein

Protein consumption has been increasing globally over the last decade. This section shall discuss the protein trend, the causes thereof, the successful products taking advantage of this trend, as well as the factors to consider when preparing a protein-based product.

According to New Nutrition Business, the protein trend is attributable to several factors in the public mind. According to a 2015 study, 53% of American citizens actively seek high-protein foods and 21% consider themselves protein-deficient (Steve French, 2015). Additionally, in 2015, the USA market recorded a 5% increase in meat consumption, the greatest single year increase in 40 years (New Nutrition Business, 2017).

In the European market, 77% of consumers believe protein is an important part of their diet, 49% don't know how much protein to consume, and 70 of the world's 80 largest consumer goods markets consume too much protein (European Whey Processors Association, 2017) .

It is challenging to determine the root cause of the protein trend. According to New Nutrition Business, consumers believe protein is inherently beneficial. These benefits range from a broad health halo to better hair, firmer body and weight loss (New Nutrition Business, 2017). This belief, according to NNB is the cause of the protein trend.

There are strong indications that meat consumption into the future is likely to remain strong (Gourmet Retailer, 2017). It has been projected that meat products will grow globally at a rate of 1.7%, a rate only exceeded by vegetable oil (Henchion, Maeve, et al, 2014). Key areas in which this growth shall occur are developing countries such as Asia, Latin America and the Middle East.

The processed meat products market segment is rising at a CAGR of 8.4%, and is estimated to be worth US\$1.5 billion by 2024 compared to the US\$760M in 2015 (Cision PR Newswire, 2016).

According to New Nutrition Business the 'winners' in this category are meat snacks and dairy snacks. The Epic Bar (previously discussed in the current report) is touted for its 11% growth over the previous 3 years. In addition, NNB reports the UK meat snack market volume was up 16% in the year 2016 to US\$175M. The most promising products were reported to be dairy, broths and snack legumes.

There are many factors that affect the success of a protein-based product. It is projected that protein will reach saturation in the next few years. This saturation will lead to differentiating factors other than price. These factors are quality, safety, environmental impact and cruelty-free processes. To succeed in this competitive sector, any product will need to take full advantage of all these motivating factors. (Trienekens, J., Wognum, P., Beulens, A., & van der Vorst, J, 2012).

4.3.1.2 Fragmentation and personalisation

Fragmentation is a current trend developing among consumers that revolves around a growing distrust in dieticians and other diet experts (Bruce, 2017). The result of this trend is a large consumer group that has decided to ignore the advice of diet experts and have decided to do their own research using resources found on the internet (Bruce, 2017).

The current personalisation trend involves consumers moving away from the standard “one-size-fits-all” diets, such as the ketosis diet and paleo diet (Egan, 2017). This has seen them move towards diet plans that are more specifically-tailored towards their own bodies, as it is believed this will allow them to achieve their dietary goals more efficiently (Egan, 2017).

Fragmentation

The fragmentation trend is most easily attributed to an increased feasibility of access to internet resources such as blogs, social media and apps. The rise of these sources of information comes at the same time as increased doubt in experts in the field. There is an increasing perception of incompetence and a growing amount of distrust surrounding dieticians and nutritionists. This doubt has come as the result of increasing news reports of these groups providing incorrect information and failing to appropriately aid their clientele (New Nutrition Business, 2017).

An investigation was performed into the word “nutritious” to determine just how different consumer and expert opinions differ. A plot of the different snack foods examined, and the way they were evaluated by the two groups, is shown below.

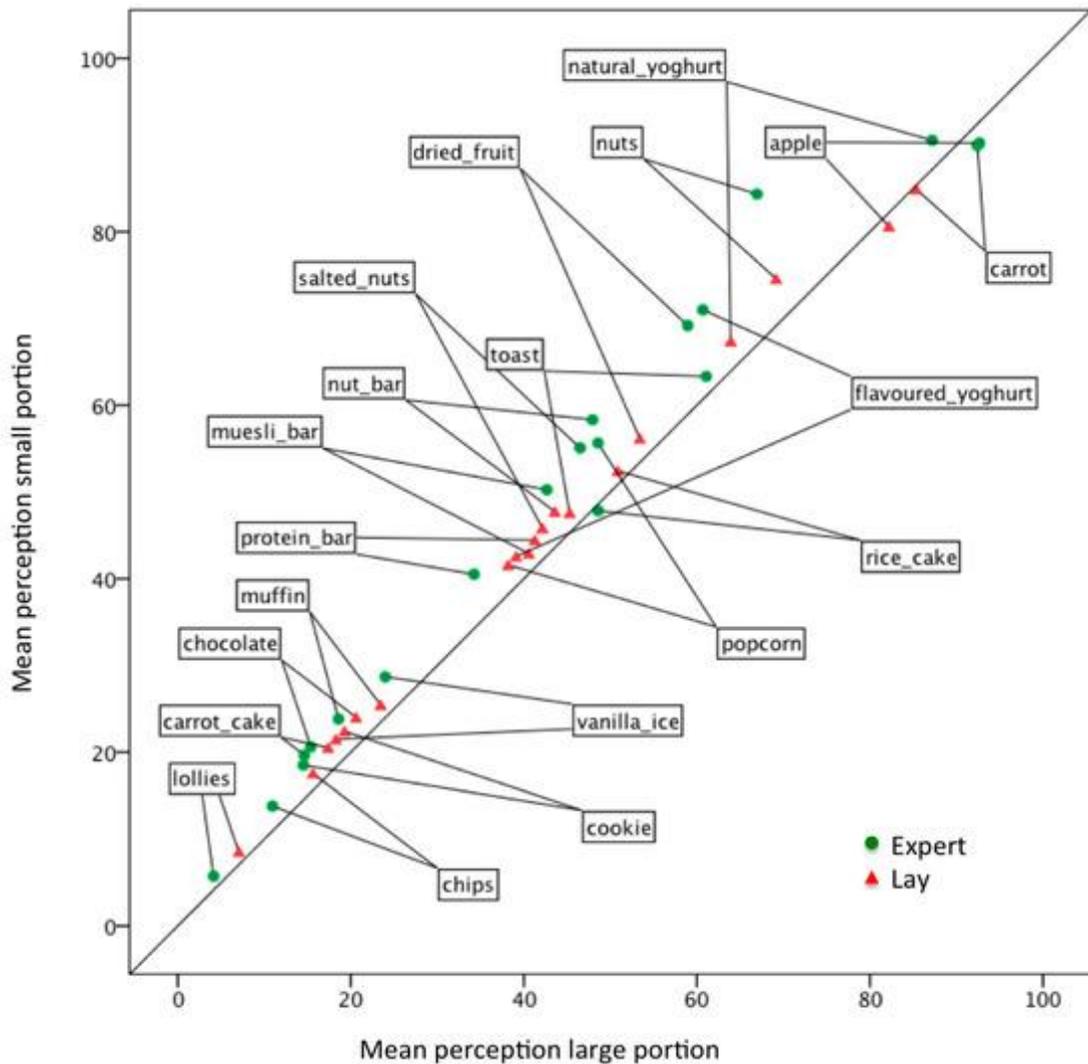


Fig. 23: Different snack foods according to “nutritiousness” (Bucher, Tamara, et al., 2017)

It can be evaluated from this plot that there is some agreement between lay persons and experts when discussing foods that are commonly known to be healthy (such as carrots, apples and nuts). However, there are large disparities evident between expert opinions and those of a lay person when referring to more obscure foods such as flavoured yoghurt, natural yoghurt and popcorn. This leads to the suggestion that the consumer is becoming less-informed and ignoring advice from professionals.

It is possible for dried meat to take advantage of this fragmentation. There is strong emphasis towards alternative diets such as ketosis, paleo and raw. If properly targeted, dried meat products can fall directly into these diets as the optimal product.

Personalisation

The personalisation trend is characterised by food companies offering platforms that “get to know” the consumer. One example is a \$32M investment by Campbells in a diet personalisation start-up (Hilario, 2016).

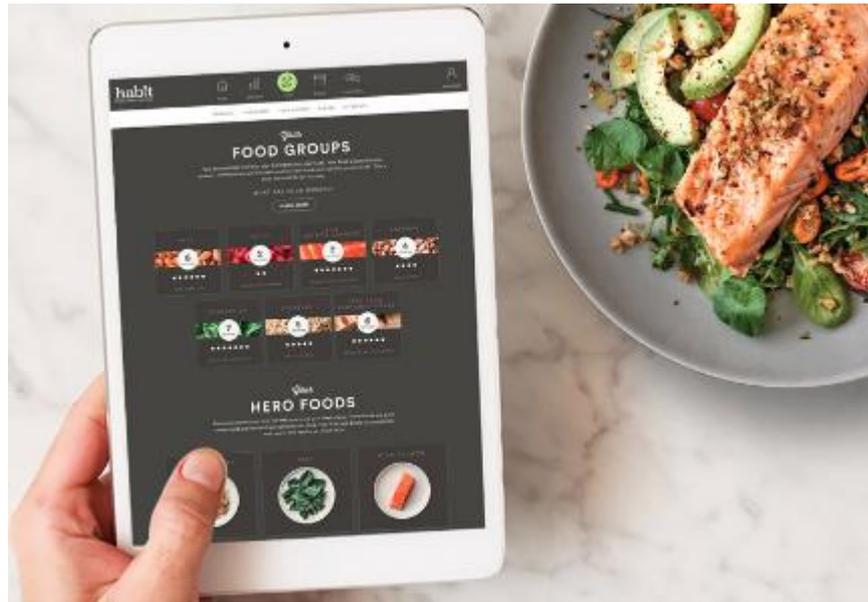
Similar to the fragmentation trend, personalisation is characterised by a distrust in professionals in the food sector and also by a distrust in ‘one-size-fits-all’ fad diets (Egan, 2017). The platform in which Campbells invested is called Habit, and it aims to provide tailored personal nutrition recommendations to all of its users.

Many of these platforms utilise home DNA test kits to provide bespoke advice for a fraction of the cost of a professional who, according to the users of these apps, won’t provide bespoke service as is (Hilario, 2016). It is therefore likely that the focus of Habit has allowed it to take advantage of the growing rift between consumers and food experts, while also keeping a distance from the realm of the fad diets.

This presents an interesting and challenging opportunity for the dried meat industry to take advantage of. On the one hand, if dried meat providers can partner with, or provide their own bespoke nutrition platforms, they will be well-positioned to provide dried meat to this market.

On the other hand, given the nature of these platforms, it is likely that one can only make profit on these products if a successful product is already in the market, thus making redundant the need for the platform.

From the perspective of the red meat opportunity, this is a potential partner and not necessarily a direction for product development.

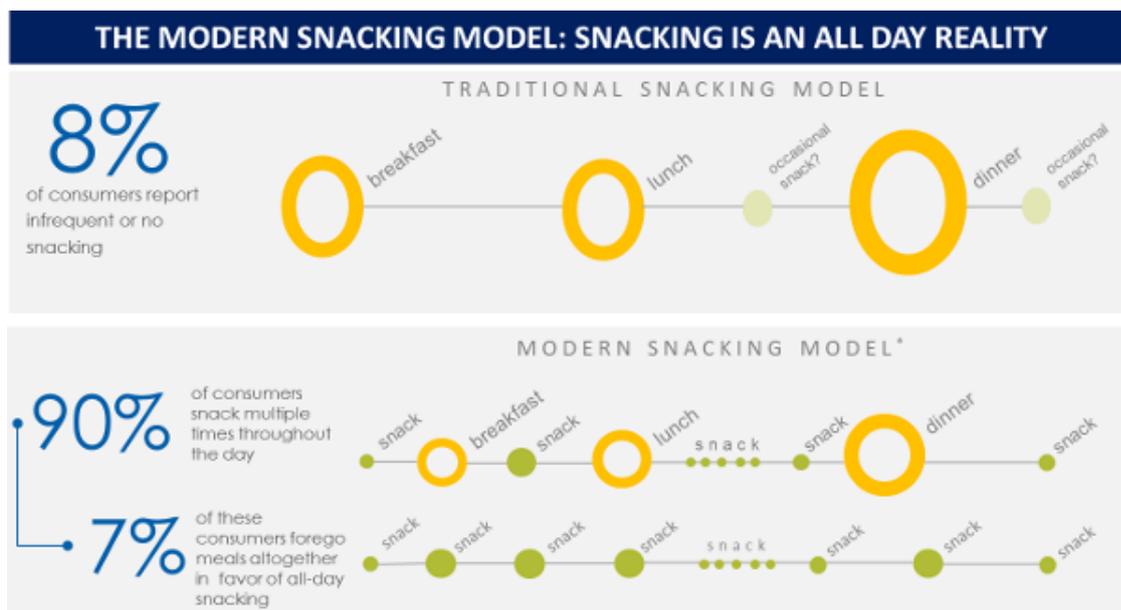


The figure above shows the Habit app

4.3.1.3 Snackification

Snackification, also referred to as grazing, is the trend towards snacking and away from large meals three times a day. This section shall discuss the characteristics of the snackification trend, the snack market and the characteristics of a successful snack food product.

This trend is supported by the shift towards an on-the-go lifestyle, meaning people are eating around their schedules, as opposed to scheduling around meal times. The figure below shows the patterns of eating in the past, as compared to today (Hartman Group, 2016)



“Modern-day snacking is driven by the on-the-go, time-starved lifestyle of today’s shopper. They don’t have the time to carefully plan, prepare and then sit down to eat a traditional breakfast, lunch or

dinner,” Brooke Steeneck, Senior Manager, Category Strategy and Insights, C-store, for The Hershey Co. “Instead, they have to grab convenient, easy and widely-available snacks throughout the day to supplement their smaller main meals.” (CS News, 2017)

It is important, at this juncture, to understand the global trends in the snacking market. It is projected that by 2024, the snack food sector will grow by a further 12% (CS News, 2017).

An investigation by Welch Foods Inc found that 92% of snackers aged 18-35 would have a snack instead of breakfast. It is projected that snacking will be a US\$635 billion market globally by 2020 (strategyr, 2015). The key opportunity areas highlighted are salted, bakery and confectionary snacks.

Additionally, some analysts have noted a significant gap for meat snacks. Devro stated:

“If you're not already involved in meat snacks, it's time to consider it. And if you are already part of the game, there are things you can do to leverage your business even more.” (Devro, 2017)

Finally, successful snack foods can be characterised by the following trends and properties:

Trends

- A preference towards functional snacks
- High popularity of low carb snacks
- Consumption of protein fortified snacks
- High popularity of organic snacks

(strategyr, 2015)

Properties

- Convenience
- Portability
- Innovation
- Versatility
- Variety

(CS News, 2017)

A snack food provider who can capitalise on these trends and properties will, in theory, be able to enter this growing market with ease.

Due to the current size of the market and the large amount of forecasted growth, a business who has made a successful entrance into the market will be able to reap the benefits within the near future.

5. Design-led thinking investigation

5.1 Introduction

The second section of this investigation entails a series of design-led thinking investigations to uncover potential products which would otherwise be unthought-of. This approach focuses on the following three aspects:

1. Technical feasibility
2. Commercial viability
3. Consumer desirability

With these three tenants in mind, interviews were conducted with the following individuals:

1. Sam Burke, Corporate Chef, Global Marketing MLA
2. Nick Hazell, Ex-R&D Director for Mars
3. Lisa Sharp, Chief Marketing and Communications Officer

This section of the report shall detail the outcomes from these discussions.

5.2 Sam Burke – Corporate Chef: Global Marketing MLA

Sam Burke is an Executive Chef and Hospitality Operations Manager with over 20 years of industry experience.

Sam built his career with one of Australia's largest commercial caterers, Spotless. Commencing as an apprentice chef, he completed his trade and continued to progress through a diverse range of hospitality businesses including The Taronga Centre, Commonwealth Bank and Sydney Cricket Ground.

Other key elements of his role included developing and executing training packages, ensuring efficiencies in procurement and maintaining key supplier and industry body relationships. Sam also fulfilled various management roles in business, industry and education catering facilities across Australia, including major sporting events such as the 2000 Olympics and Rugby 2003 World Cup.

Sam is a well-rounded culinary professional who is not afraid of hard work. He is a proud ambassador for Australian produce, specifically beef, lamb and goat meat.

Along his culinary journey, Sam has always been a believer in the training and development of the "next generation of cooks". He sits on many industry workgroups to promote and mentor the next generation. Sam is an integral part of the product development portfolio of the global marketing team, connecting Australian producers of fine Australian beef, lamb and goat to the global chef and consumer community.

It was somewhat challenging to organise a phone call with Sam; his schedule is extremely full. Fortunately, after a time, it was possible to organise an hour of Sam's time, an overview of this discussion is as follows:

Question	Response
Would it be possible to integrate dried meat into a protein bar?	Certainly, most protein bars are sweet, it may be possible to grind dried meat into a savoury protein bar, or with oats into a sweet option.
What other applications for dried meat do you see?	There are applications for dried meat in buns, for example brioche for a burger. I'm always brainstorming ideas for what people would find appealing from a food service application.
We've noted that dried meat is often a low-quality meat product, trimmings and the like. If the dried meat is cheap, does that help the offering?	That's a bit broad—certainly, it depends on how the product is being used as to whether it's going to save money. If you do a whole plate of jerky, as opposed to a steak, of course the jerky is more expensive. If you use it as a sprinkling/crumb for a pasta dish, or pancetta or croutons in a salad, or like bacon bits, that would work well.
Dried meats are typically pork based, why is this? Can we make similar products with beef?	This is simply a tradition thing, it's totally possible to make these products with beef, and it's just the way things have been done in the past. There's nothing to stop beef achieving the same things as pork. Look at Turkey and the Middle East, they have a dish called beef pistama, this is similar to pastrami, it is often mixed in with eggs in the morning. Additionally, you can't forget the halal market. It's totally possible to make these products to appeal to this market.
How do the different markets compare in terms of their consumption of meat and potential consumptions of dried meat?	A product produced for the American market is likely to be totally different for the Asian market. In America, the meat is the centre of the dish and more is more. In Asia, it's likely to be more of an aside, focusing more on the rice or noodle component. The one thing I can see working in both markets is something like dried meat for a crumble or a salt (like chicken salt). These would provide much-needed flavour to both markets.
How do different chefs from say café and fine dining compare to say caterers?	These are totally different markets with totally different goals. Your aged care caterer is looking to do the best they can on tight budgets and provide the right nutritional requirements. The up-market chef is always looking to get a leg up on the competition. They're always looking for the next big thing. To that end, a product aimed at one market is unlikely to appeal to both, unless we could make a flavour additive, which also contributed to the aesthetic of the dish and could therefore appeal to both markets. To the fine dining chef, the price of the dish is not as important as the quality and wow factor. Whereas, the caterers really care about cost.
Let's consider the texture of the dried meat	There are many ways in which the texture of the dried meat appeals to the chef. If we were to incorporate it into a loaf that would deliver texture, similarly, if we were making baked potatoes, we would find it useful to apply a rub of dried meat powder. If we have something texturally-soft like noodles, this could help a lot in terms of the texture. We could use it in something like fried rice, or noodles or something little and easy like that.
How would dried meat play into the hands of say a ready meals company like Youfoodz?	That's a challenging one. A big focus of those guys is the freshness of the product. To that end, it's hard to incorporate a dried meat product into one of those dishes in such a way that it complies with their approach.

Question	Response
Could jerky-flavoured chips work?	Yes, we would need to work out the detailed balance of this product but that is certainly something along the same lines as what we've been considering.

The key themes from Sam's interview were that it is possible to use dried meat as a flavour additive. This would appeal to chefs of all kinds and countries. Depending on the specifics, this could be made to work for fine dining chefs and caterers in all places around the world.

It was pointed out that there is chicken salt so why not have beef salt. It was also pointed out that dried beef pieces could be incorporated to a wide range of dishes as a 'bacon-bits' style addition.

It was found that dried meat would not work very well in a ready meals type application, due to the desire for freshness in this market.

5.3 Lisa Sharp – Chief Marketing and Communications Officer

Lisa and her team deliver world-class data and insights, marketing strategy and communications for the Australian red meat industry, both domestically and around the globe.

Working closely with all elements of the supply chain, data and insights deliver value back to the farm gate. The insight capability and thought leadership contained in this team is designed to position MLA as the expert in the purchasing, eating and cooking habits of shoppers and consumers, as well as domestic and global food trends.

Lisa has extensive experience in food marketing and consumer understanding. Lisa has a strong professional history in marketing companies including SPC and Coca-Cola Amatil.

The discussion with Lisa centred primarily on consumer trends and the trends in the market, especially surrounding protein, natural products and snacking. Less discussion was made regarding new products, while more around the way the consumer would look at these products.

Question	Response
One of the things Sam suggested was dried meat as an ingredient for chefs, like a crumb or sprinkle, what do you think of this?	There are a lot of things to consider when determining whether to make a product or not. This is especially relevant when we consider selling things to chefs. For starters, as you were saying, if we wanted to leverage the 'Australian-ness' of the product, that would be challenging at best. We struggle enough to get this information provided for something like an Australian wagyu steak. So, for something that's just a sprinkle or an ingredient, that would be hard. We would need the product to have a unique value proposition around its flavour and texture, such that people seek it out on its merits on the plate alone.
What are the things people look to Australian produce for and why wouldn't	There's a lot to be said of why people want Australian produce. We need to consider the freshness, safety and the naturalness of the produce and we also need to think of the integrity. These are different things that different customers look for, depending on their income. For example, we see more wealthy people looking for the safety and integrity and the animal welfare. This contrasts with the low socioeconomic groups who don't really care

Question	Response
dried meat provide these things?	about the safety that much. They just want to put food on the table and it doesn't matter where it came from. There're just doing the best they can.
So what value could a dried meat product offer these people, given that it doesn't need the refrigeration?	Long shelf-life is a totally different proposition to the other attributes of Australian produce. The safety of the Australian product is a key part of this. If we think ahead 5 years from now and see a mature-dried meat product that targets this market, we would see that the Australian product would stand heads and shoulders above the rest, because of safety. Perhaps it would make sense for Australia to go into this market. Because it allows us to take advantage of the positive connotations of our product in new markets, this would have its challenges in positioning.
What are the kinds of people that would most likely enjoy the intense flavour of dried meat?	There are groups in the US and Europe—the young, committed foodies. These people are explorers, they want that intensity, in addition to the naturalness and the integrity, but these people are also looking for the new and different things. When we look at the dried meat for this, there is something to tap into—there's and intensity that flows through to their food. If we could take advantage of this consumer segment, with dried meat and its intensity of flavour, that could be a strong market.
If we look at snacking, how does that play into using this product?	Protein is coming back in favour but what we are looking for in our protein is under greater scrutiny. This creates the market for replicates and replacements. If this is something that's derived from an animal, can it ever deliver what people really want? If someone wants whey, they won't want this product. In short, we aren't going to capture the gym junkie looking for protein powder. We may, however, capture a market of people looking to try something new and the less-committed gym junkie, depending on the individual product.
Are there brands seeking to use high protein product?	<p>Yes, many people are doing something like this. There are a handful of large players who keep looking at snacking. One of the special features of this product for a snack, is its protein-richness and savouriness. We don't have a lot of products like this and how will it fit in? Everyone is talking about it but the rubber hasn't hit the road. The only format that this works for with dried meat, is not delivering the experience people want from their snacks.</p> <p>If we consider this from the perspective of gender demographics, we see that women and men want different things from their snacks. Women associate beef with big beefy blokes and why would they want to eat something like that? They expect a different experience to that which we are delivering.</p> <p>Another important point to consider is the young-man demographic. There are a lot of young men who aren't eating beef as much as they could be, as they used to.</p> <p>There are young men and women who really understand the place of protein in the diet and there are people who don't want this in their diet in the same way that they used to. Today, men don't want the fatty protein we have in beef. This is leading to changes in our diets. Now, given dried meat is typically lean, perhaps there are some opportunities there.</p> <p>This should be the snack food of the future, but we aren't breaking ground at the moment, because of these challenges.</p>
Does the fact that dried meat can	I think so, there are many challenges in terms of positioning, but there are certainly some opportunities there. On a price per kg basis, beef is four

Question	Response
provide intense flavour, position it well to take advantage of the small serving sizes that Asian markets tend to use?	times as much as chicken. But in terms of the benefit, there are benefits in terms of the flavour. We like our beef because it delivers a juiciness, tenderness and flavour. If we look at this as just a flavour, that's a different situation. If I think about how I cook now, I think less about the cut of meat, I'm looking at this as a flavour base. This means meat is not the centrepiece of the dish. If I'm balancing the budget I can use this as a good basis of the meal, without using as much of the meat and we can use less-expensive meats. In Jakarta, they use much less meat but we are cooking more Asian-inspired meals in Australia. But we make a much more expensive edition of the flavour. We can use meat in this dish as a flavour.
Does the animal welfare play a part in the Australian story about the value of our meat in other countries?	This is interesting, because the value of things like this is proportional to your income—the less you have the less you care. So, if we were targeting the middle-income earners in Asia, we would see some concern. However, not as much regarding the welfare of the animal, it's just not as important when you're just trying to make ends meet.

5.4 Nick Hazell

Nick has extensive experience in the design-led thinking process and has led innovation for companies such as PepsiCo and Mars. Nick is credited with the invention of popular savoury snacks such as the Grainwave and the truffle Red Rock Deli chip. For this project, Nick brought his extensive experience to the fore and gave some insights not previously considered. Nick also provided many mind maps which have been provided in the appendices.

Question	Response
What is your typical process for inventing a snack food?	Well it's rather simple and repetitive at this point. We get a substrate, usually something made of corn, then we dehydrate the substrate, so we have the right textures. Then we add the flavour to the surface. This flavour needs to be on the outside of the food, because this allows it to get all the impact on the mouth and nose. We never waste flavour on the inside of the food because this would not reach the places it needs to be. For Example, Red Rock Deli chips we see that all the potato substrates are the same. It doesn't taste like much, to be honest. Which means that we can add all the flavour to the outside, without much interference from the substrate. Additionally, the substrate needs to be as cheap as possible.
So, in the case of meat, how do we take the flavour of meat and apply that to a chip?	Interestingly, we made a chip with the flavour of Hunter Valley chicken. This was then challenged, we had to prove we actually made the food with Hunter Valley chicken. However, in that case, we didn't really use that much chicken. We used some, but not much and, as is the case with all the chicken and meat flavourings, we don't actually get meat, we get the things you associate with the meat. For example, with chicken, chicken salt is actually thyme and rosemary. Your brain then makes the association with chicken

	but if you eat chicken flesh on its own, pan fried or whatever, it doesn't taste like that a whole lot.
So then to make jerky-based flavour, we need to find that other thing that makes beef flavour?	Yes, well obviously in the case of Maggie noodles, there is already beef flavour and in many cases, there are more efficient ways to make the flavour than to actually use beef, and people have done that. Perhaps a more relevant question is "would people pay for more meat-based flavour products?". The answer is yes IF, for example, I have done some work with these guys to bring actual meat-based flavour to the people. The thing they see is that the meat is expensive and drives up the price of their product, which means they wouldn't be willing to produce at this mark-up. The thing is that the consumer, the people who buy the flavour, want the real meat, they want to be able to say we actually put meat in this and not flavour. So, there's certainly opportunity there to make a product that uses more meat and people actually want in the industry, and that is really innovation.
How does jerky play in this whole thing? Are we fooling ourselves with the increasing sales figures?	Jerky is horrible, from all perspectives, it's a terrible snack food. The texture is bad, people don't get a satisfying aftertaste that leaves you wanting more and it's such a journey to chew through a piece of jerky. It can't be an effective snack food, because people don't want to go through that. I think there is certainly potential though, because like you said, there are large sales of this stuff in the states which suggests we actually have a market who's willing to buy something—even if it's horrible. The question is, how do we make this product something better? Because if we can do that, we can tap into a much larger consumer segment.
So how does the flavour industry work?	The international flavour companies, there are 6 or 7, they take amino acids, yeast and some other chemicals and mix them in such a way that it's really a science at this point. They make a flavour so intense and precisely suited to the needs of the consumer. They do not take real ingredients and distil them to an extract for consumption, because often, that distillation is actually not what the people want from their flavour experience. They want the thing they thought it tastes like, the association. This does mean that if you were able to make a product that had beef flavour, people would buy it for thousands of dollars a kilo. However, no one is willing to make it.
So what other things are worth considering given all the questions we've posed?	Japanese rice bowls came up and that's an interesting application. Those have a high content of Umami. If we can take that and find a high Umami flavouring that's based on beef, that could be successful in this market.
If we consider other properties of dried meat, such as no need for cold chain, can we target the lower socioeconomic groups who don't have cold chain compliance?	If we are targeting these groups, we see that these groups, in India for example, aren't getting their protein from meat but instead from legumes. Further, the cold chain independence of dried meat comes at a cost. The drying process is expensive and we need to keep that in mind when we considered the ability of these people to buy the product. I was working on a product to target the lower socioeconomic market and what we found was that the product needs to cost 10, preferably 5 rupees, which is about the same number of cents in Australia. Anything like freeze-dried

	<p>spaghetti bolognese, or something like this, simply won't work. It's more expensive than the other product and these people can't afford spaghetti bolognese to start with. Indeed, if we were to sell such a product in India, we wouldn't have a lot of meat in it. For example, we could see that such a 50g meat product would actually be 1g meat and the meat would really be stretching as far as it could to make the most impact.</p>
<p>So, let's talk about other meat products that might be relevant, like Epic Bar</p>	<p>The Epic Bar is actually terrible. There are alternatives that cut the product with veggies and that one is okay, I still don't see it as the best thing ever. But it's okay. Epic has a very interesting market; its 70% women and it seems to be women trying to get more protein outside of meal times and they don't know how. This is an opportunity for jerky, or a rethink of jerky, if we could make something that gives the experience, we would get a much larger consumer segment.</p> <p>A real opportunity for MLA is to rethink jerky.</p>
<p>With the new jerky, how might that fit into the market in terms of brand?</p>	<p>If we consider the brands of PepsiCo for example, there's really no brand that hits the consumers you want, while fitting the product, such that the product doesn't hurt the brand. You might have to make a whole new brand which is not optimal. The product needs to tick the boxes of protein and snacking and deliver the sensory experience the people want.</p>
<p>Do you see dried meat as a good product for fast food?</p>	<p>In a word, no. These groups have menus that change on a very well-regimented rotation and they don't really try anything that might upset the consumer. They have a small provenance segment with the angus beef, but I don't see them ever trying anything ground-breaking. I can talk to the MacDonald's Marketing Director to see how they would feel about this idea. An interesting thing in their marketing was that Dominoes needed to change their approach to include meals for the mum—because she didn't go to dominos because there wasn't a salad for mum. So they included that salad at a loss, so they could get the \$60 order of pizza.</p>
<p>What about military applications?</p>	<p>Interestingly, the same people who buy the Epic Bar are the people who buy military products and MREs. The properties of these foods are maximal flavour, nutrition and shelf life, as well as some digestive things. If you're stuck in a tank, you don't want to be requiring the toilet a lot. There's the opportunity to produce a freeze-dried bolognese product which can be rehydrated with some hot water. The extra processing isn't really an issue for bolognese, we already cook the meat to within an inch of its life and its pretty stable, it just might lose a bit of flavour.</p>
<p>If we pull on the freeze-dried bolognese thread, is that a product we could make?</p>	<p>Well, we need to consider the occasion. If we are looking at the Maggie noodle occasion, people want something cheap and a few calories. If we replace that with a freeze-dried product, we see it's going to cost 5x as much, which is more than anyone will be willing to pay for that food.</p>

Is there a thread you see for us to pull on for a future project?	Collagen refinement is very popular and makes excellent snack foods. It's a 100% meat product and it makes a delicious meat snack. It starts as a low-value meat product and it can be converted into something people really want, like pork crackling. Additionally, if we were to consider protein extraction for beef protein powder, but I don't see that working well, given the low cost of whey.
What about for pharma/nutraceuticals?	Some father thinking is that we could put it into a face rub, we know that meat can stop wrinkles for a time, but it's not my field of expertise. For that to work, you apply protein products to your face.

5.4.1 Primary findings from discussion with Nick

- There's the opportunity to develop a meat-based flavouring product with one of the international flavour houses.
- There's an opportunity to develop a new kind of jerky—Lisa and Nick agree it's not delivering what people want
- Freeze-dried bolognaise, and other similar products, may be effective ways forward for dried meat

6. Opportunity spaces

6.1 Key opportunity spaces

6.1.1 Free trade agreements and their effect on Australia's beef and agricultural exports

With the instalment of free trade agreements (FTAs) between Australia and the countries of Japan, China and Korea, a huge opportunity space for the Australian beef industry has been created.

Over the coming decade, these agreements will result in large reductions – or even the elimination – of import tariffs and quotas on a variety of goods, including both fresh and processed beef products. This will encourage greater export volumes of Australian beef, and increased revenues for the industry at large.

The most significant market opportunity exists in China, currently Australia's largest export market worth \$10.3 Billion AUD, as of 2016. The market has grown by 50% since 2011, and this robust growth is expected to continue well into the future, following the introduction of the China-Australia Free Trade Agreement (ChAFTA) (Trade, 2017).

Under ChAFTA, import tariffs for 'processed foods' – a definition which likely encompasses dried and cured meat products – will be eliminated completely by 2024 (Trade, 2017). This will result in increased revenues for importers, allowing Australian producers of dried and cured meat products to focus more of their time and assets into tapping into this growing market. Furthermore, tariffs for all fresh beef, sheep and goat products will be removed by 2024, meaning the market opportunity for beef exports to China is expected to grow drastically in the coming decade (Trade, 2017).

Australia's second-largest export market, Japan, is also a prime growth area, especially following the enforcement of the Japan-Australia Economic Pacific Partnership Agreement (JAPEPA) in January 2015 (Trade, 2017). Japan has a growing snack market estimated at \$12 billion AUD (Condon, 2014), and one

of the best markets in the world for distribution of processed foods. The nation has the world's highest density of vending machines, with one for every 23 people (Jacobs, 2017), and a high density of convenience stores – one for every 2,300 people (Ministry of Economy, Trade and Industry Japan, 2016).

The introduction of JAEPA has made the Japanese market even more attractive for Australian companies. Tariffs on the importation of prepared and preserved beef, and all other beef products, reduced by between 20-40% (Trade, 2017), a significant decrease from the rate of 29.8% before the JAEPA was established.

Furthermore, Australian imports are now exempt from the 50% 'global snapback' tariff that the Japanese Government implements as a safeguard whenever beef imports rapidly increase (Trade, 2017). When combined, these factors create an opportunity for manufacturers of dried and cured meats to capitalise on a growing market, with efficient distribution channels.

Lastly, the Korean-Australia Free Trade Agreement (KAFTA) is expected to stimulate a greater amount of trade between the two countries, with tariffs on beef exports to Korea to drop from 40% to zero by January 2028 (Trade, 2017).

Since beef is Australia's largest export to Korea, the reduction in these tariffs will help promote the growth of local business and the increase in capital will allow domestic beef producers to expand.

The market opportunity space for processed beef products such as dried and cured meats is also expected to grow, as tariffs are to be reduced from 72% to zero by the year 2028 (Trade, 2017). This significant reduction in export costs presents an opportunity for Australian manufacturers to increase their exports of dried beef products to Korea.

6.1.2 Opportunity of halal meat snacks in Middle East

There is an extremely large market for Halal meat from Australia, with approximately \$1.6 billion worth of exports to countries such as Saudi Arabia, United Arab Emirates and Malaysia (Cochrane, 2016). The market to create a dried halal meat snack exists, and the right advertisement and preparation could lead to development opportunities.

Brazil had the largest market of Halal meet in general for many years, until the USA started rejecting their beef products in 2016, due to increased health standards. The main factor was the components of a foot-and-mouth disease vaccine, which did not pass health inspections.

Their market subsequently dropped, as much as 19% in one week, yet the demand continued to rise (Bickers, 2017). Australia had an estimated Halal market of \$8.5 billion in 2013, which grew significantly to approximately \$13 billion in 2014-2015. For meat alone, the growth was \$1.6 billion to around \$2.1 billion. In 2018, the global market for Halal meat is approximately worth \$2.1 trillion (Zielinski, 2015).

With Brazil currently having a significant decrease in exports, and 25% of the world population being Muslim and thus Halal consumers, the opportunity for profit in this industry is greater than ever. Additionally, Halal food is generating interest with the rest of the world, who consider it to be food of higher quality and safer for consumption.

Currently, Australia is exporting Halal meat to countries such as Saudi Arabia, the United Arab Emirates, Egypt, Malaysia and Iran, who are importing Halal meat at values of between \$2.7 billion and \$0.8 billion AUD.

Other notable import locations are Jordan, Qatar, Indonesia, Kuwait and Libya, with imports of between \$500 and \$600 million (Cochrane, 2015). With Australia leading in exports to the Middle East, there would be plenty of opportunity to offer a Halal dried meat snacks to generate interest (Anon., 2007).

Muslims were responsible for purchasing 17% of all food and beverage sold worldwide, making up \$1.1 trillion USD (Latif, 2016). Yet, there is a noticeable gap in food that promotes convenience. For people living a lifestyle of constant work and little spare time, the demand for food that is quick and nourishing is expected to rise. Therefore, the demand for a Halal snacks would also increase. There is no current business that exports Halal jerky from Australia, opening an opportunity for a large export market.

The main players in Halal meat snacks are from the USA, and one from Malaysia. As of 2018, the main Halal jerky exporters are (Latif, 2016):

- **Midamar Halal** – produce a Halal beef jerky snack that is exported globally
- **Halal Jerky** – have 12 different products. Available in retail stores in US and online.
- **Sharifa Halal** – Turkey and beef snacks based in the USA and sold through retail and third-party
- **Fajaru Marketing** – Malaysian-based that created the Mat Dendeng (Indonesian dried meat)

While these companies can become obvious competitors, the demand is still there for Halal jerky and Australia is ready to capitalise on a new market.

As one of the most trusted Halal meat supplying countries, Australia could target Saudi Arabia, the UAE and other Middle Eastern countries. The main target would be millennial Muslims, who may have already had exposure to this type of snack from overseas countries, but would be unable to try it, due to cultural practices. A dried Halal meat snack would be a sizeable opportunity that would access an audience of 25% of the world's population and MLA should remain aware of it.

6.1.3 South African Foot and Mouth Disease (FMD)

South Africa is home to a large market for biltong – a traditional variant of jerky – with the industry valued at \$2.6 Billion USD (Cloete, 2015). Beef demand has consistently outstripped local supply (by 4.3% in 2013), making South Africa a net importer of beef. A significant majority (64%) of these beef imports come from Australia (South African Institute of International Affairs, 2014).

There exists a significant, permanent risk to South African beef: Foot and Mouth Disease (FMD), which has seen two outbreaks in the past three years, one of which resulted in a huge reduction in edible beef supplies. Should South Africa experience another significant outbreak of FMD, there will be a strong opportunity for Australian companies to export both fresh and dried beef products to fill the gap in demand.

FMD overview

Kruger National Park, located in the north of South Africa, is internationally-recognised as major source of virulent Foot and Mouth Disease (FMD) (Brückner, et al., 2003). The virus infects the large, wild populations of water buffalo in the region. Contact with livestock can cause the spread of FMD

(Brückner, et al., 2003). FMD causes sores on the feet and mouth of cattle, making them unsuitable for human consumption.

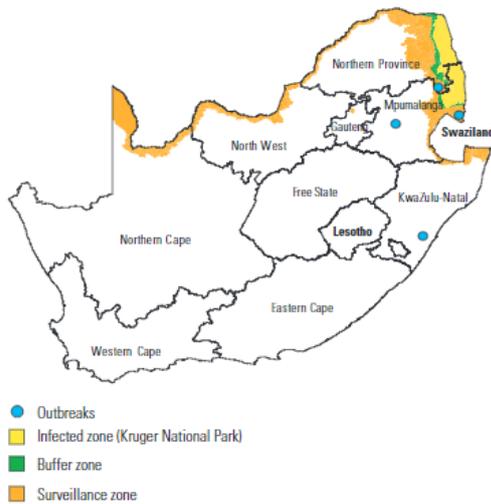


Fig. 22: Map displaying outbreaks of disease (Brückner, et al., 2003)

To prevent the spread of FMD and the collapse of the agriculture industry, The South African Department of Agriculture, Forestry and Fisheries (SADAF) has implemented a controlled zoning system (Brückner, et al., 2003).

There are four zones: the infected zone (Krugersdorp National Park), the buffer zone, the surveillance zone and the vaccination-free zone, which comprises the clear majority of South Africa.

A map showing the location of the zones and outbreaks of FMD is shown in Fig. 23 (Brückner, et al., 2003).

The buffer zone surrounds Krugersdorp National Park and is separated from the park using game fences and natural land formations (Brückner, et al., 2003). Policy within this zone is strict, with livestock requiring vaccinations against FMD strains SAT 1, 2 and 3, twice a year and inspections every 7 days (Brückner, et al., 2003). The movement of livestock is strictly regulated to prevent livestock within the buffer zone being moved into the free zone. Regulations within the surveillance zone are more relaxed, with inspections occurring every 14 days (Brückner, et al., 2003).

The vaccination-free zone is a status granted to South Africa by the World Organisation for Animal Health (OIE), the organisation that regulates and monitors the status of FMD in every country across the world.

However, due to an outbreak of FMD in February 2011, South Africa lost this status (Esterhuizen, 2014), causing serious exportation issues for the country. The country's trading partners imposed serious import restrictions on South African beef, reducing annual export quantities from 13,000 tonnes to 7,000 tonnes almost overnight. This resulted in an estimated loss of \$360 million USD per year (Esterhuizen, 2014).

While South Africa currently retains their FMD vaccination-free zone status, they have, in the past three years, suffered from two outbreaks of FMD. The first occurred in the Limpopo area on the 10th of December 2015, where it is believed the infection was caused by contact between cattle and wild buffalo from the Kruger National Park (eNCA, 2015). The second, and more recent outbreak, occurred on the 21st of August in 2017 in the Giyani Local Municipality (South African Department of Agriculture, Forestry and Fisheries, 2017). South Africa did not lose their FMD vaccination-free zone status in this case, as the outbreaks occurred within the FMD protection zone, which comprises both the buffer and surveillance zones (South African Department of Agriculture, Forestry and Fisheries, 2017) (eNCA, 2015).

Opportunities

Moreover, there exists a significant chance that another outbreak of FMD could occur in South Africa, causing serious harm to both the exportation and local consumption volumes of meat products. If an outbreak occurred that was serious enough to warrant the loss of their FMD vaccination-free zone status, a huge market opportunity would arise for the Australian red meat and dried meat industries to export beef to South Africa.

This presents a potentially large market opportunity for Australian dried meat producers to supply South Africa with both fresh and processed meat products. South African producers will be faced with increased production costs, as they must import fresh meat from other countries to create biltong, as well as importing biltong ready-made. This would result in both increased export volumes and revenues (albeit temporarily) for the Australian meat industry, and increased awareness of Australian meat to foreign markets.

Currently this market opportunity does not exist, but it is important for dried meat producers and industry peak bodies, such as the MLA, to be aware of the situation in South Africa, so that they may capitalise on the opportunity should it arise.

6.1.4 Opportunity space 4 – Dried Meat as a Flavour Additive

There exists the opportunity to explore dried meat as a flavour additive.

This was touched on by both Sam and Nick. This suggests that not only is the idea a good one, but it was simultaneously come to by multiple people at opposite ends of the food spectrum. The two ideas are slightly different, but essentially are based on the same concept: using dried meat as a flavour enhancer for dishes.

Sam's take was to use dried meat as a crumb, sprinkle or soil for executive cooking or catering. This product, if properly textured and intensely flavoursome, could be sold at a high price point per kg, as a seasoning—as opposed to a conventional product—thus, this presents a substantial value add opportunity.

Nick's take was slightly different but reflects work he has done in the past on developing a new product for the snack food industry, but didn't take off because of top level executives in IFF. Nick's idea is to steer the international flavour houses towards developing flavourings based on real ingredients, as opposed to yeasts and amino acids. This would permit the food product producer to sell their product as flavoured with real beef, as opposed to flavoured with flavours.

Nick lamented that there will be challenges to this product. The international flavour houses are somewhat stuck in their ways and are not likely to produce this product under the current regime. The challenge for them is the 4-fold increase in raw product cost. Yeast and amino acids are cheap. Meat cuts, by comparison are expensive. This makes the flavour house nervous, as they would have to sell their flavour additives at a higher price. Nick is confident there is a market for this increased price product, as the portion of the expense of a packet of chips made up by the flavouring is miniscule and so, in the eyes of the end consumer, the increase of 10-20c is not important, especially when the product is now premiumised and flavoured with natural ingredients.

6.1.5 Opportunity space 5 – the reinvention of jerky

Through discussions with Nick, it was apparent that his opinion was somewhat negative towards jerky as it is. In Nick's opinion, jerky is not only a poor product but people buy it because it is close to what they are looking for but if we were able to change the experience of jerky we could be able to crack a much larger market and make jerky a legitimate competitor for chips.

A similar sentiment was expressed by Lisa when discussing the appeal of jerky, Lisa suggested that jerky is not delivering the sensory experience people are looking for, additionally, jerky has a limited appeal to women because beef is associated with big beefy blokes and why would women want to consume this product.

When we think of products like the Epic Bar, we see there is a product out there that seems to be successfully targeting the female market, which is looking for ways to get their protein requirements. If jerky could be reinvented to deliver the same outcomes as the Epic Bar but with a superior experience, it will be possible to take advantage of a much larger market and expand the use of beef as a value add product.

7. Conclusion and recommendations

This report investigated the potential new applications for dried meat products. A technological review was performed with regards to several new drying technologies. These technologies were assessed to applicability to red meat products. Following this, the investigation turned to inspect the dried meat products markets globally. Finally, the report inspected the consumer trends and uncovered a number of opportunity spaces within these trends.

The findings of the technological assessment were as follows:

1. The majority of new drying processes are not applicable to meat
2. Microwave vacuum drying may merit further investigation in partnership with JBS
3. The current ways in which dried products are currently produced (tray drying and freeze drying) are unlikely to be disrupted, except perhaps by microwave vacuum drying.

The findings of the market assessment were as follows:

1. Dried meat and other snacks make up a very small segment of the snack market
2. The best way for dried meat snacks to increase market share is not to try to expand the jerky market share, but to take market from other snacks under another name entirely.

The primary findings were as follows:

1. The consumer is disappointed with the sensory experience of jerky
2. There exists the potential to reinvent jerky to deliver the experience the consumer is looking for and capture a much broader market than that which jerky captures currently and, potentially, pose a legitimate threat to the potato chip.
3. There exists the opportunity to explore dried meat as a flavour additive for chefs, either as a soil, sprinkle or crumble. This product could be sold at a high price and, if sufficient demand were generated, could be highly successful.
4. There exists the opportunity to develop a meat-based flavour additive with one of the international flavour houses. This product would cost more than conventional flavours, according to the way they are developed currently, but would allow the producer to label their product as flavoured with meat (as opposed to flavoured with artificial flavours).

It is recommended that the following projects be conducted to take advantage of the findings of this report:

1. Industry partnership with an international flavour house: the opportunity for dried meat as a flavour product
2. Industry partnership with Australian chefs: The opportunity to use dried meat as a luxury ingredient for cooking
3. The redevelopment of Jerky: project with large food producer to find the meat snack that delivers the outcomes consumers are really looking for to provide protein at snack time

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9. Appendix:

9.1 Appendix A:

A list of major jerky suppliers in Australia and the flavours of jerky they sell.

Brands of Jerky	Types of Jerky
Bald Rock Beef Jerky	Original
Bigwig Jerky Company	<ul style="list-style-type: none"> • Original • Peppered • Smoky Chorizo • Chili Lime • Teriyaki • Peri Peri • Honey Soy & Sesame
Branxton Beef Jerky	<ul style="list-style-type: none"> • Smashing Sweet Chilli • Soothing Mild • Super Smokey BBQ • Succulent Garlic • Scorching Hot Chilli
Butcher Boy	<ul style="list-style-type: none"> • There are 5 standard flavours available: • BBQ • Teriyaki • Garlic • Cracked Pepper • Chilli • There are 5 alcohol flavours available: • Bourbon • Beer • Rum • Red Wine • Port
D.Jays Beef Jerky	<ul style="list-style-type: none"> • Smokey • Chilli • Traditional
Darling Jerky	<ul style="list-style-type: none"> • Original • Cheeseburger
First Choice Beef Jerky	<ul style="list-style-type: none"> • Chilli • Spicy
Geronimo Jerky	<ul style="list-style-type: none"> • Pow Wow • Original • Spicy Shaman • Buckshot • Sidewinder • Blazin' Saddle • Flamin' Arrow • Stampede (with Guarana)

Brands of Jerky	Types of Jerky
Heavenly Jerky	<ul style="list-style-type: none"> • Guarana Extract • Honey Bourbon Flavour • Dark Rum Flavour • Signature Flavours
Humpty Doo Jerky	<ul style="list-style-type: none"> • Original Beef Jerky • Greek Goat Jerky • Spicy Beef Jerky
Jacks Black Label	<ul style="list-style-type: none"> • Safari • BBQ • Chilli • Piri Piri • Maple • Garlic
Jim's Jerky	<ul style="list-style-type: none"> • Safari • BBQ • Garlic • Piri Piri • Chilli • Bloody Hot Chilli • Honey Soy • Korma Curry
Kims' Beef Jerky	<ul style="list-style-type: none"> • Original Beef Jerky (Curry & Lemongrass) • Satay Beef • Sesame Beef
Mariani Foods Beef Jerky	<ul style="list-style-type: none"> • Types: • Beef • Crocodile • Emu • Kangaroo • Flavours: • Hot and Spicy • Teriyaki • Original • Bulgogi
Ol' Pete's Beef Jerky	<ul style="list-style-type: none"> • BBQ • Original • Bacon • Chilli
Ripsaw Jerky	<ul style="list-style-type: none"> • Mild • Warm • Hot • Cracked Pepper • Outback Roo
Silvers Beef Jerky	<ul style="list-style-type: none"> • BBQ • Char Grill • Chilli Beef • Chorizo

Brands of Jerky	Types of Jerky
	<ul style="list-style-type: none">• Salt and Pepper• Snake Bite Chilli• Snake Bite Venom• Teriyaki
Territory Jerky	<ul style="list-style-type: none">• Original Beef Jerky• Hot Beef Jerky• Flamin' Hot Beef Jerky• Camel Jerky
Wild Bull Jerky	<ul style="list-style-type: none">• Original• Hot Chilli• Honey Teriyaki

9.2 Mind maps



