CREATING ECONOMIC GROWTH BY HARNESSING HIDDEN VALUE

Project name: NZ Venison Co-Products Nutritional Characterisation & Value Addition

Project Leaders: Talia Hicks, AgResearch and Carolyn Lister, Plant & Food Research

Project Contributors: Jihan Kim and Santanu Deb-Choudhury, AgResearch; Suba Sivakumara, Kris Tham and Siva Sivakumaran, Plant & Food Research

Date: 30 June 2022

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Executive Summary

In 2018, approximately 851,000 head of deer were farmed in New Zealand (NZ), with 362,000 head slaughtered for venison production (207,000 rising 1-year old males, 125,000 rising 1-year old females, 30000 cull females); producing 16,733 tonnes of venison meat and accounting for $198 million in export revenue [1]. In addition to the primary products, around 12,132 tonnes of venison co-products were exported, bringing in an additional $47 million in revenue. These co-products are comprised of offal and hides. Although hides have continued to remain profitable, offal prices have dropped, and markets have been disrupted. Therefore, to improve the utility of venison offal, full nutritional profiling has been undertaken to explore the nutritional properties of common offal and co-products for applications in human edible products.

The purpose of this project was to characterise the nutritional profile of venison offal and co-products for publication in the NZ Food Composition Database (NZFCD), describe their attribution in the human diet and highlight potential value addition strategies for venison offal and co-products for a range of food-grade product types. The nutritional profiling included characterisation of the 88 Core Components required for producing 'Food Records' in the NZFCD, as well as additional nutrients (vitamin K, biotin, pantothenic acid, choline, chloride and fatty acids) for venison heart, kidney, liver, lung, spleen, tongue, sinew, tendon, blood, tail and gelatine. The results of the nutritional profiling have been published on the publicly searchable NZFCD to support both consumers' understanding of venison offal and co-product nutritional composition for when they are preparing meals at home, and also to support the food industry in formulating new products and meals from these products.

In terms of contribution to the recommended dietary intake (RDI) of an average adult, the venison offal and co-products characterised were shown to be a source or good source of many macro- or micronutrients required in the human diet at reasonable serving sizes (e.g., 100 g for wet products and 10 g for dried products). Heart, kidney and liver were shown to provide the highest contributions to RDI for the broadest range of nutrients, followed by spleen, lung, tongue and blood. Although tendon, sinew and tail showed lesser contribution of key nutrients, they were still found to contribute to several micronutrients, whereas gelatine only meaningfully contributed to protein intake.

Exploration of value additional strategies for venison offal and co-products were limited to edible product categories including whole tissue products, processed and novel foods, soups, stocks and flavourings, and supplements. Most of the strategies that were considered are employed by the deer industry (or wider food processing industry) already for the sale of deer products (namely meat, offal, blood, gelatine and velvet), suggesting there is relevant knowledge and infrastructure in the industry which could support production of a wider suite of these product types prepared from different offal and co-products.

It is recommended that the deer industry continue to pursue growing their markets for minimally processed foods (e.g., whole tissue), processed foods (e.g., novel foods and ingredients with unique sensory properties like flavour) and wellness products (e.g., protein, vitamin and mineral supplements) which have been shown here to be sources of key nutrients in the human diet.

Scope

The purpose of this project was to characterise the nutritional profile of venison offal and co-products for publication in the NZ Food Composition Database (NZFCD), describe their attribution in the human diet and highlight potential value addition strategies for venison offal and co-products for a range of food-grade product types.

The information that goes into the NZFCD includes:

- Food name
- Food density
- Food nutritional composition
- Information about the sample's origin, such as method of collection, and method of preparation for nutritional analysis.

This report highlights the nutrients of dietary significance found in venison offal and co-products based on their nutritional composition and their contribution to the human diet on the basis of percentage daily intake (DI), recommended dietary intake (RDI) and estimated safe and adequate daily dietary intake (ESADDI).

This report goes on to highlight product categories where offal and co-products can be used to produce edible products, including some emerging innovations published in academic literature and considerations for the handling, storage and post-processing and cooking of these raw materials/ingredients.

Acknowledgements

AgResearch and Plant & Food Research would like to acknowledge the support of Deer Industry New Zealand and the Bioresource Processing Alliance for funding this work and providing in-kind support and access to the offals and co-products.

Methods

Nutritional Composition of Venison Offal and Co-products

Preparation of Offal and Co-products

Methods for preparation of the offal and co-products for measuring their densities and preparation of composite samples for nutritional analysis can be found in Appendix 1. Results from determination of offal and co-product densities are presented in Appendix 2. The densities of the products are reported in the NZFCD to support informing the public of nutritional information for measures commonly found in recipes used during home cooking (e.g., on a per cup of diced offal basis). **Note:** the NZFCD database also provides results on a per gram basis.

Nutritional Analysis of Offal and Co-products

Methods used to assess the nutritional composition of the offal and co-products can be found in Appendix 3, outlining the assays and laboratories used. Results of the nutritional analysis are presented in Appendix 4 on a per 100 g basis. The contribution of key nutrients to an adult's diet are presented in Appendix 5 which are calculated on the basis of daily intake (DI), recommended dietary intake (RDI) and estimated safe and adequate daily dietary intake (ESADDI) for specific serving sizes (100 g for wet products, 10 g for dried products). In addition, the full spreadsheets of data are available where serving sizes can be changed to recalculate the data including percent DIs/RDIs/ESADDIs.

Exploration of Value Addition

Food-grade product categories that include red meat offal and co-products were explored through a search of academic literature, new products (Global New Products Database, Mintel Group Limited), retail and e-commerce channels. The categories include:

- Whole tissue
- Processed products and novel foods
- Soups, stocks and flavourings
- Protein, vitamin and mineral supplements

Each section highlights some of the products currently available for sale that include red meat offal and co-products, as well as some of the benefits and challenges of creating new products in these spaces. Finally, a brief outline of some of the considerations that must be given to the handling, storage, post-processing and cooking of offal and co-products is reported.

Results: Assessing Nutritional Value

Nutritional Composition Results

The nutritional composition results are presented in Appendix 4. The sum of proximates should fall within a range of 95–105 g per 100 g edible portion. A margin of plus or minus 5% is considered acceptable [2]; this is because many of the food components are determined independently on different samples in different laboratories. This has generally been the case with most of the products tested. However, a higher proximate sum of 106 g/100 g and 105 g/100 g was calculated for tendon (M10083) and sinew (M10084) respectively. The reason could be the general nitrogen to protein conversion factor of 6.25 overestimating the protein (which were 35.8 g/100 g and 34.8 g/100 g respectively). This is supported with the total amino acids being 29.3 g/100 g (M10083) and 28.5 g/100 g (M10084) being lower than the calculated protein. A lower proximate sum of 94 g/100 g was calculated for gelatine (M10086). This could be due to its lower moisture content 5.7 g/100 g (M10086) compared to the value of 11 g/100 g reported in Australian Food Composition Database [3] and 13 g/100 g in FoodData Central [4] and the UK Composition of foods integrated dataset [5]. However, an erroneous or low water content (and therefore proximate content) for gelatine (M10086) is not necessarily indicative of errors in the micronutrient composition presented for gelatine.

Considering Nutritional Value

When considering foods for human nutrition it is important to put it in the context of daily requirements, and in terms of labelling an understanding of what claims can be made. Nutrient content and health claims are voluntary statements that refer to a relationship between a food and a component or health benefit.

In NZ and Australia claims are classified into nutrition content claims, general level health claims and high-level health claims (in overseas markets these may vary slightly but in general similar principles apply). The Ministry of Primary Industries (MPI) provides the following definitions:

- *A nutrition content claim states how much of a nutrient or substance is in a food. Examples might be, 'a good source of vitamin C' or 'gluten-free'.*
- *A general level health claim links a food product to a health effect that relates to general health and wellbeing. An example might be 'Calcium is good for strong bones'.*
- *A high-level health claim identifies products that can protect against a serious disease or a risk factor for a serious disease. An example might be 'Diets high in calcium and vitamin D may reduce the risk of osteoporosis'.*

Food Standards Australia New Zealand (FSANZ) regulations dictate what nutrient content and health claims can be made on foods in NZ and Australia. To determine the significance of nutrients and apply pre-approved health claims it is important that nutrients are expressed on a percentage DI, RDI or ESADDI per serve basis. The FSANZ labelling DI/RDI/ESADDI values are outlined in Tables 1 to 3. Vitamins and minerals, with the exception of potassium, can be claimed as a source at 10% RDI/ESADDI and a good source at 25% RDI/ESADDI per serve (as specified by FSANZ, 2018 [6]).

Table 1: Daily intakes (DIs) for core nutrients for food labelling purposes as specified in FSANZ Standard 1.2.8 [7].

Food Component	**Units**	**Reference Value**
Energy	kJ	8700
Protein	g	50
Fat	g	70
Saturated fatty acids	g	24
Carbohydrate	g	310
Sodium	mg	2300
Sugars	g	90
Dietary fibre	g	30

Table 2: Vitamin and mineral daily requirements as specified in Schedule 1 of the Food Standards Code [6] and source/good source thresholds as specified in Schedule 4 [8].

Nutrient	Units	Adult requirement	RDI or ESADDI	Source	Good source
Vitamins					
Biotin (B5)	µg	30	ESADDI	≥3	≥7.5
Folate (B9)	µg	200	RDI	≥20	≥50
Niacin (B3)	mg	10	RDI	≥1	≥2.5
Pantothenic acid	mg	5	ESADDI	≥0.5	≥1.25
Riboflavin (B2)	mg	1.7	RDI	≥0.17	≥0.43
Thiamin (B1)	mg	1.1	RDI	≥0.11	≥0.28
Vitamin A	µg	750	RDI	≥75	≥188
Vitamin B6	mg	1.6	RDI	≥0.16	≥0.4
Vitamin B12	µg	2	RDI	≥0.2	≥0.5
Vitamin C	mg	40	RDI	≥4	≥10
Vitamin D	µg	10	RDI	≥1	≥2.5
Vitamin E	mg	10	RDI	≥1	≥2.5
Vitamin K	µg	80	ESADDI	≥8	≥20
Minerals					
Calcium	mg	800	RDI	≥80	≥200
Chromium	µg	200	ESADDI	≥20	≥50
Copper	mg	3	ESADDI	≥0.3	≥0.75
Iodine	µg	150	RDI	≥15	≥37.5
Iron	mg	12	RDI	≥1.2	≥3
Magnesium	mg	320	RDI	≥32	≥80
Manganese	mg	5	ESADDI	≥0.5	≥1.25
Molybdenum	µg	250	ESADDI	≥25	≥62.5
Phosphorus	mg	1000	RDI	≥100	≥250
Selenium	µg	70	RDI	≥7	≥17.5
Zinc	mg	12	RDI	≥1.2	≥3

Abbreviations: ESADDI = Estimated Safe and Adequate Daily Dietary Intake; RDI = recommended dietary intake

Table 3: Claimable concentrations for other nutrients as specified in Schedule 4 of the Food Standards Code [8].

Nutrient	Claimable amount	Source	Good source
Cholesterol (low)	<20 mg/100 g		
Energy (for contributing energy for normal metabolism)	≥420kJ/serve		
Fat (low)	≤3 g/100 g		
Monounsaturated fatty acids (MUFA)		≥40% MUFA and <28% saturated and trans fatty acids	
Omega-3 fatty acids[a]		≥200 mg ALA acid/serve or >30 mg total EPA and DHA/serve	
Omega-6 fatty acids		≥40% omega-6 and <28% saturated and trans fatty acids	
Omega-9 fatty acids		≥40% omega-9 and <28% saturated and trans fatty acids	
Polyunsaturated fatty acids (PUFA)		≥40% PUFA and <28% saturated and trans fatty acids	
Protein		≥5 g per serve	≥10 g per serve
Potassium[b]	≥200 mg per serve		
Saturated and trans fatty acids (low)	<1.5 g/100 g		
Sodium/salt (low)	≤120 mg per 100 g		

[a] must also contain as a proportion of the total fatty acid content, <28% saturated fatty acids and trans fatty acids; or <5 g saturated fatty acids and trans fatty acids/100 g
[b] there is just a single threshold for potassium so can just say contains/source and not good source
Abbreviations: ALA = alpha-linolenic acid; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid

In Schedule 4 of the Food Standards Code [8] there is a list of pre-approved health claims that can be used when nutrients meet the prescribed concentrations. To use pre-approved health claims, foods must also meet the Nutrient Profiling Scoring Criterion (NPSC). The NPSC is a nutrient profiling system used to determine whether a food is suitable to make a health claim, based on its nutrient profile. Further details on the NPSC can be found in 'Short guide for industry to the Nutrient Profiling Scoring Criterion' [9]. The NPSC takes into account the energy, saturated fat, sodium and sugars content of the food, along with certain ingredients such as fruit and vegetables and, in some instances, dietary fibre and protein. Points are allocated based on 100 g or 100 mL of the food (based on the units used in the nutrition information panel, NIP). The profiling score can be calculated using FSANZ's Nutrient Profiling Scoring Calculator [10].

Nutrients of Dietary Significance in Venison Offal and Co-Products

Nutrients of dietary significance for human nutrition in each of the offal and co-product samples are given below. These are given per 100 g at present, apart from the dried samples (tail and gelatine which are given per 10 g). It is important to note that the serving size will vary depending on how the products are used/consumed.

- Blood (per 100 g):
  - Source: selenium
  - Good source: protein, niacin, iron
- Gelatine (per 10 g):
  - Source: protein
- Heart (per 100 g):
  - Source: biotin, copper, phosphorus, potassium, zinc
  - Good source: protein, niacin, pantothenic acid, riboflavin, thiamine, vitamin B6, vitamin B12, iron
- Kidney (per 100 g):
  - Source: vitamin B6, copper, potassium, zinc
  - Good source: biotin, folate, niacin, pantothenic acid, riboflavin, thiamine, vitamin B12, iron, phosphorus, selenium
- Liver (per 100 g):
  - Source: copper, potassium
  - Good source: protein, biotin, folate, niacin, pantothenic acid, riboflavin, thiamine, vitamin A, vitamin B6, vitamin B12, vitamin C, iron, phosphorus, selenium, zinc
- Lung (per 100 g):
  - Source: biotin, pantothenic acid, copper, phosphorus, potassium, selenium, zinc
  - Good source: protein, niacin, riboflavin, vitamin B12, iron
- Sinew (per 100 g):
  - Source: niacin
  - Good source: protein, vitamin B12, vitamin D
- Spleen (per 100 g):
  - Source: riboflavin, phosphorus, potassium, selenium, zinc
  - Good source: protein, niacin, vitamin B12, iron
- Tail, dried (per 10 g):
  - Source: protein, niacin, calcium, phosphorous
  - Good source: vitamin B12
- Tendon (per 100 g):
  - Source: niacin, vitamin B12
  - Good source: protein
- Tongue (per 100 g):
  - Source: pantothenic acid, riboflavin, vitamin B6, iron, phosphorus, potassium, zinc
  - Good source: protein, niacin, vitamin B12

FSANZ provides a list of pre-approved health claims and these are detailed for the nutrients above in Appendix 6. These can be mapped to a number of general wellness areas:

- Bone health
- Brain and nervous system
- Cell & tissue growth
- Digestive health
- Energy & metabolism
- Eye health
- Growth & development in children
- Hair & nails
- Heart & circulation
- Hormonal function
- Hydration
- Immune function & inflammation
- Joint health
- Oral health
- Physical performance
- Pregnancy
- Prevention oxidative damage (antioxidant)
- Reproductive health
- Skin

Thus, there are lots of opportunities for utilisation of these venison offal and co-products in supporting human health and nutrition. For consumers to benefit, this may require the deer and wider food industry to more actively promote the benefits of venison offal and co-products in the diet, and create a suite of products that are desirable to a broader range of consumers than the traditional demographics.

Results: Value Addition Potential Product Categories

This section explores the opportunities for developing food-grade products from the offal characterised: whole tissue foods, processed products and novel foods, ingredients such as soups, stocks and flavourings, and protein, vitamin and mineral supplements.

Whole Tissue Offal

There are markets where offal is highly regarded for its texture, and remains part of traditional cuisine throughout Europe, South America, North America, Asia and Africa. Offals are available in their natural state (Figure 1), and they can be prepared and consumed in a variety of ways, typically cooked by boiling, roasting, smoking and frying [11].

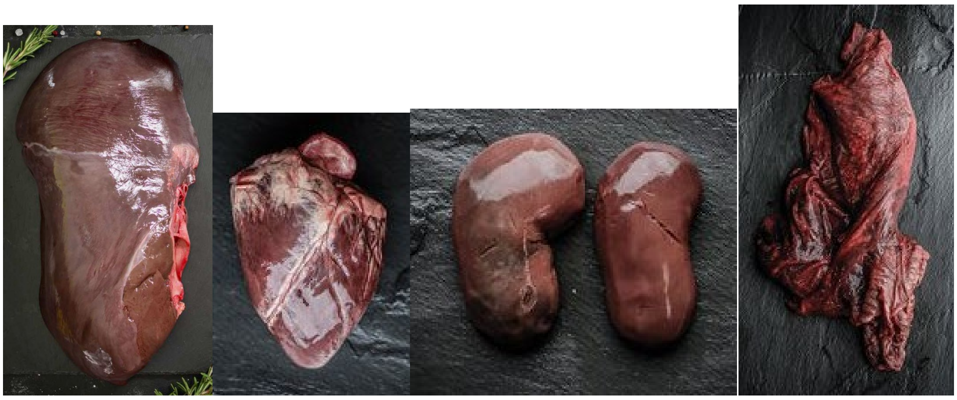

Figure 1: Examples of unprocessed venison offal, from left to right:1. Venison liver, Coombe Farm Organic, United Kingdom, 2. Venison heart, Curtis Pitt Deer Services, United Kingdom, 3. Venison kidney, Curtis Pitt Deer Services, United Kingdom and 4. Venison lung, Curtis Pitt Deer Services, United Kingdom.

Opportunities

Despite their excellent nutritional reputation, the current utilisation of offal in most western diets is limited due to their lack of appeal. Some of the reasons behind consumer aversion to offal meats, blood and other co-products include perceived safety risk, strong flavours, unappealing appearance or considered inappropriate to eat (e.g., a visceral reaction), as well as a lack of familiarity of their use in prepared meals [12].

One strategy to improve consumption of offal may include the development of ready-to-heat or ready-to-eat meals from whole tissue offal made available with all the necessary ingredients and cooking instructions. These types of products are gaining momentum through the growth of online direct to consumer sales, with businesses such as Eat Ltd, Fitfood©, Hello Fresh™ and The Food Company operating in NZ. As this product would be positioned as a premium food product due to the nature of the service, further consideration would need to be given to the packaging to retain the desired sensory experience.

Benefits:

- Selling as fresh or frozen edible offal requires minimum additional process operations.
- Co-products sold as edible offal may be more valuable than pet foods, provided the right market can be identified.

- Selling convenient ready-to-heat or ready-to-eat meals may be an easy way to incorporate low value cuts, offal and co-products into meals already familiar to consumers.

Challenges:

- High capital outlay and potentially high operating costs, similar to those for rendering or pet food due to additional costs associated with packaging and chilled or frozen storage.
- High level of product development required to obtain the desired sensory properties, especially for ready-to cook/heat/eat meals.

Processed Products & Novel Foods

Offals have been used traditionally to prepare a number of processed meat products including small goods such as sausage, chorizo and meatballs, which generally have greater consumer acceptability than their whole-tissue counterparts (Figure 2).

Figure 2: Examples of processed food containing venison offal, from left to right:**1.** Polca, Belgium, Polca (Venison Pâté with Armagnac), **2.** Messner Wurst und Schinkenspezialitäten, Austria, Messner (Vennison Liver Loaves), **3.** Rekedal Pølsefabrikk AS, Norway, Rekedal Pølsefabrikk (Venison Sausage – Venison, Heart) and **4.** Perez Palacios, Spain, Coto Real (Jerked Venison Chorizo).

Beyond traditional products, there have been several attempts published in academic literature which have incorporated animal co-products into common foods. These include the use of blood in cookies [13], cake [14], surimi [15] and restructured meat products [16]; the addition of bovine kidney, lung and heart into fortified infant cereal products [17]; the use of bovine lung, liver, spleen and bone in snack foods [18], as well as beef lung protein powder incorporated into fresh pasta [19].

In addition, protein hydrolysates prepared from porcine blood and other animal co-products have been transformed into potential flavourings/seasonings via an enzymatic engineering process [20, 21]. Further, collagen-rich offals such as skin and feet have been used as food ingredients, with the collagen extracted from offal being used as an emulsifier which can play a role as a fat replacer for meat products when incorporated with dietary fibre [22].

Over the past 10 years, AgResearch Ltd has undertaken research to incorporate meat as an unexpected food ingredient in popular foods not typically associated with meat. These have included the addition of lean meat and lower value cuts to products such as ice cream, yoghurt, spaghetti, chips, gnocchi, bread and chocolate to formulate nutrient-boosted foods [23]. These products are otherwise high in carbohydrates, and some have low levels of readily digestible protein and other nutrients. The product categories were intended for elderly consumers, but when tested many showed good levels of acceptability for people of all ages.

Opportunities

The fortification of traditional foods with meat is able to alter the nutrient profile and potentially increase the protein content by 50%. In addition, it creates new textures and flavours to satisfy discerning consumers with high expectations for an exceptional eating experience. Currently, these novel products have not been commercialised. Therefore, there is potential for offals and low value cuts to be incorporated into novel food products to diversify the market for edible co-products locally and internationally.

Novel foods, which incorporate offals or their derivatives, may also be prepared in such a way as to target infants, elderly, athletes and patients who require specialised nutrient profiles in their diets to satisfy their health conditions and activities. For example, nutrient- and energy-dense food may be favoured by athletes to enhance their performance, whereas patients may also require key nutrients to aide their recovery.

Benefits:

- Selling offal-fortified foods such as pasta or minced meat may be an easy to way to incorporate offal or other co-products into food products already familiar to consumers.
    - Inclusion levels can be optimised for flavour and quality.

Challenges:

- High capital outlay and potentially high operating costs, with additional costs associated with mincing, drying or packaging offal ingredients. More-so if additional food processing equipment is required to produce novel foods.
- High level of product development may be required to obtain the desired sensory properties, especially when designing traditionally non-meat food types (e.g., pasta).

Soup, stocks and flavourings

The high protein present in offal and co-products can be exploited through the creation of ingredients such as stocks and flavourings (Figure 3). Transformational research is required to develop new high-value ingredients from co-products which have proven functionality and sensory benefits. Both protein source and processing can induce modifications to the protein which will have an impact on the development of flavour. Further, extraction and delivery technologies to maximise the functionality and flavour of co-product derived ingredients while maintaining consumer-valued “naturality” is also important.

Figure 3: Examples of soups, stocks and flavourings containing venison offal, from left to right: **1.** Baxters, UK, Baxters Chef Selections (Scottish Venison, Sloe Gin & Juniper – Venison Meat, Bone and Liver), **2.** Baxters, UK, Baxters Luxury (Highland Game Soup – Venison Meat and Liver), **3.** Unilever, Belgium, Knorr Fond (Game Stock – Venison Extract), **4.** Feinkost Menzi, Germany, Menzi (Venison Stock - Bones), and **5.** Best Chef, Switzerland, André Heiniger (Wild Sauce – Venison Powder).

Although NZ venison is known for its mild flavour, the high protein content of both meat and offal lends itself to the generation of much richer, umami flavours through pre-processing (e.g., hydrothermal processing). Umami compounds may enhance consumer acceptability of flavour-enhanced foods. Research has demonstrated an enhancement in feelings of satisfaction and positive emotions associated with an umami-rich meal, without any compromise in the perception of the health benefits of the meal. Moreover, the acceptability of a rich savoury flavour produced by Maillard reaction products is also found to be high in consumers and may play an important part in the development of flavour-enhancement products such as soups, stocks and condiments.

Meaty flavours that stimulate the gustatory senses and evoke memories of home-cooked meals are strongly desirable, especially with umami and kokumi taste enhancers, roasty overtones, a slightly sweeter taste profile and an enhanced feel of creaminess. These flavouring products may not include excess saturated fat, cholesterol, or sodium and may also be fortified with important micronutrients or designed to be added to a range of nutrient-dense foods.

Opportunities

Soups, stocks and flavourings are already well understood by consumers. There is potential to develop new flavourings which offer greatly enhanced eating experiences using product development techniques coupled with metabolomics and peptidomics assessment of the final products – in conjunction with their food pairings. The use of a wider variety of food processing techniques along with mass spectrometry will allow scientists to optimise the underlying chemistry, identify complementary ingredients and enhance the sensory perception of meals prepared at home, in the factory or in a restaurant.

Benefits:

- "De-animalising" offal is one way to overcome the hurdle of negative consumer perceptions of its consumption.
- Selling soups, stocks and flavourings may be an easy way to incorporate offal and co-products into ingredient formats already familiar to consumers.
- Potential to create 'unique' NZ flavour signatures for enhancing gamey meat products.

Challenges:

- High capital outlay and potentially high operating costs, similar to those for rendering or pet food due to additional costs associated with cooking, concentrating and packaging the products.
- High level of product development required to obtain the desired sensory properties.

Protein, Vitamin and Mineral Supplements

Protein Supplements

Protein isolates are popular among training athletes, particularly bodybuilders and strength athletes. Further, protein isolates such as collagen are becoming significantly more mainstream with companies such as Jeuneora and Dose & Co. producing collagen supplements for adding to smoothies and coffee.

In general, protein supplements typically take the form of powders, pre-mixed drinks and bars due to their convenient preparation and portability [24], and are made from a variety of protein sources including from plants, single cell organisms (e.g., yeasts) or animals. Protein supplements derived from muscle meat, or more commonly from collagen-rich off cuts, are commercially available (Table 4), currently retailing for $41.76 – $137.21 per kg. The majority of these products are based on beef, with some chicken protein isolates becoming available, however no equivalent product exists for venison meat or offals.

Table 4: Meat protein isolates currently sold as protein supplements (Amazon e-commerce, 1 June 2022).

Product	Description	Retail Value ($NZD/kg)	Supplier
Carnivor™	Hydrolysed Beef Isolate	$ 41.76	MuscleMeds
Platinum Beef Protein	Hydrolysed Beef Isolate	Not Available	MuscleTech®
Prime Protein Grass-fed Beef Isolate	Hydrolysed Beef Isolate	$ 137.21	Equip
BulkSupplements.com	Beef Protein Isolate	$ 45.45	BulkSupplements.com
Olympian Labs	Hydrolysed Beef Isolate	$62.80	Olympian Labs Inc.
CHXN™ Chicken Protein Isolate	Chicken Protein Isolate	$140.75	BIN

Vitamin and Mineral Supplements

Although protein supplements derived from offal and co-products appear to be unavailable, vitamin and mineral supplements are (Figure 4). Blood, spleen, kidney and liver contain the highest concentration of iron (0.4 – 2.8 mg/g dry weight from these venison offal results). Previous studies have shown that haem-iron makes up a significant portion of the total iron content found in meat, offals and blood (73% for spleen, 54% for lung, 37% for kidney, 28% for heart, 13% for liver [25] and 85% for blood [26]). Haem-iron is known to have better bioavailability than inorganic iron (15%–35% of haem-iron is absorbed, compared to 2%–20%

for inorganic iron) [27]. Dried blood has been produced into capsules (containing NZ cervine and bovine sources), selling for around $0.30 per capsule (containing 0.5 g of freeze-dried material). One of the most notable examples is the small US brand Ancestral Supplements, who are selling freeze-dried bovine and ovine organs sourced from NZ, including brain, prostate, thymus, adrenal and thyroid glands among other offals for around NZ $0.47 per capsule (Figure 5). An NZ based company Homegrown Primal is producing similar products. While small doses (~0.5 - 1 g) of dried offals provide only a small measure towards RDI for nutrients like iron, selenium or zinc, depending on the offal (e.g., kidney or liver) they could provide meaningfully toward RDI for nutrients like vitamins A and B12.

Figure 4: Examples of supplements containing offal, co-products and low value meat, from left to right: **1.** Immrei Biotech, Taiwan, Bee Zin Venus's Secret (Placenta Extract & Collagen Tablets made with sheep placenta), **2.** Biocyte, France, Biocyte Keratine Express (Anti Hair Loss Supplement made from sheep wool), **3.** Donga Pharm, Donga (Supplement for Kids made with deer velvet), **4.** Donga Pharm, Donga (Kangaroo Essence 50000 made with kangaroo meat powder) and **5.** Japan Preventive Medicine, Japan Preventive Medicine (Imidapeptide Drink made with chicken breast meat extract).

Figure 5: US Ancestral Supplements made from NZ bovine and ovine organs, from left to right: brain, prostate, thymus, thyroid and adrenal.

Opportunities

There is growing consumer interest in using natural supplementation to improve physical and cognitive wellbeing to counteract the demands of a busy lifestyle on the body and mind. One of the major opportunities for venison processors, is in leveraging the 'health halo' of venison, their skill-set producing and marketing deer velvet and NZ's pasture-raised and disease-free branding to create proven health ingredients.

This may be achieved through the preparation of minimally processed supplements (i.e., dried as is, or recovered protein isolates) which contain highly bioavailable amino acids, vitamins and minerals, or through the preparation of functionalised ingredients such as bioactive peptides which may exert anti-microbial, anti-thrombotic, anti-hypertensive, or anti-oxidative effects when consumed.

Benefits:

- Tap into learnings, industry skills and market access developed from the processing and sale of deer velvet
- Highly valuable protein, mineral and vitamin supplements can be produced from nutritionally dense heart, liver and kidneys.
- Opportunity to look at blood or lung as an iron supplement.
- Suitable for low volume processing.

Challenges:

- High capital outlay and high operating costs.
- Will require significant product development to obtain high yield product with satisfactory sensory properties.
- Will require rigorous quality assurance to ensure all product is safe (reduced vitamin A content, ensure no zoonotic diseases are present).
- May find the global market difficult to enter due to competition from beef- and chicken-based protein supplements.
- May face regulatory hurdles regarding supplementation (e.g., FDA) in future.

Considerations for Offal Processing

Handling

Edible offal products are perishable and vulnerable to pathogen contamination during removal of the viscera which contains the gut and intestines. Offal preparation must be conducted in an area separate from the meat carcass and preparation of meat cuts so that the edible co-products are protected from physical (hair, blood) and microbial contamination. Operators are also required to use appropriate equipment and comply with the appropriate regulations to prevent cross contamination.

Hygienic collection of edible co-products will typically involve washing and trimming prior to chilling and packaging. This is essential for the collection of intestines which have a high microbial load and should be washed immediately after slaughter. A number of pathogenic microorganisms found in edible offal products include *Salmonella*, *Clostridium perfringens*, *Staphylococcus aureus* and *Escherichia coli O157:H7* [28].

Washing as a conventional decontamination technique might be helpful to reduce these harmful foodborne pathogens however it is preferable to ensure the pathogens are completely eliminated before being consumed (e.g., through cooking or other techniques). Several techniques that show promise for decontaminating foodborne pathogens from meat include steam pasteurization, chemical decontamination (e.g., chlorine, organic acids and ozone), non-thermal techniques (e.g., cold plasma, oscillating magnetic fields, pulsed light, irradiation and high-pressure processing).

Non-thermal technologies are most notable as they cause less changes to quality attributes [29], with high-pressure processing (HPP) being the most widely used in the food industries, including meat industry [30]. Other non-thermal techniques are under consideration for the decontamination of meat. However, there are still several hurdles to be cleared before they can be commercially used such as cost-effectiveness, scale extension, industrialisation and validation.

Storage

Although several advanced bacterial decontamination technologies have been developed, suitable packaging and storage conditions are also important for maintaining quality and safety. Even if there is an acceptable degree of microbial contamination present on co-products at slaughter, the number of bacteria can increase during transportation from the slaughterhouse to market and during consumer storage. Therefore, like meat, edible offal must also be packaged and stored at refrigerated temperatures to control microbiological growth and prevent deterioration of the product [31].

Currently, most edible offal are collected, washed with potable water to remove contaminants and then cooled and packaged into cartons with plastic bin liners or vacuum packaging, prior to being chilled (to less than 7 °C within 16 hours) or frozen for shipment [31]. Unfortunately, there are limited studies on the impact of packaging on the final quality of edible offal during transportation and storage, with most studies having focused on the effect of different packaging methods on hygiene attributes such as discoloration and microbial deterioration [32, 33].

In terms of freezing processes, a cycle of freezing and thawing process is known to cause cryogenic damage due to the ice crystal formation disrupting the cell membranes, resulting in protein denaturation and the acceleration of oxidative stress which negatively impacts product quality [34]. Moreover, this cryogenic damage may result in a loss of moisture, minerals and soluble protein that are associated with nutrition and quality. Further, the protein oxidation derivatives such as oxidatively modified amino acids and peptides that tend to resist digestion might be metabolised by gut microbiota turning into carcinogenic compounds [35]. This is an area which would require further exploration in future to ensure the co-products have a good shelf life as well as quality.

Post-Processing and Cooking

Post-processing of offal into new products will require a number of possible processing techniques to present the original products in new ways. As mentioned above, in bulk, offal is often immediately frozen. Considering thawing process, the thawing time and temperature should be minimised to reduce microbial growth, chemical deterioration as well as excessive water loss. Thus, quick thawing at a low temperature is desirable [34].

Basic processing of meat products often includes cutting and grinding (mincing). These processes increase the surface area exposed to heat, light, oxygen, enzymes and metal ions, accelerating lipid oxidation, which can lead to off-flavours and odours (and reduced quality and nutritional value) [36]. In addition, the process mixes any surface contaminating microbes such as spoilage and illness-causing bacteria throughout the product, which can negatively impact shelf-life and quality, as well as pose a risk to consumers [37]. These issues will occur with offal as well, but to a greater or lesser extent depending on the starting tissue and its nutritional composition (e.g., iron-rich offal such as lung and liver may be more pro-oxidative than tissues like tendon which are lower in iron). The impact of processing on product quality and safety should be explored on a case-by-case basis.

Enzymatic hydrolysis process is often used to improve functional attributes of protein derived offal [38]. The attributes of protein is dependent on the type of enzymes and raw product quality [39]. However, high incubation temperature and long incubation time to activate enzymes may cause undesirable microbial growth and oxidation.

Drying and fermentation techniques to improve nutritional quality are used for non-meat wastes [40]. In particular, the fermentation technique is often used for adding value to agriculture co-products such as soybean meal and canola cake that are considered wastes or low value product [41]. Thus, fermenting animal offal might be a technological breakthrough to not only add value to animal offal but also inhibit the growth of pathogens.

High temperature cooking method denatures protein structure of offal resulting in loss of water and mineral, whereas low-temperature and long cooking time cooking method called “Sous vide” of beef liver between 60 and 80 °C has been shown to have no deleterious effects on the fatty acid and mineral composition of the product [42]. Other cooking methods may result in losses due to the solubility of some vitamins and minerals, warranting exploration during new product development.

Conclusions

It is well known that animal tissues such as meat, offal and meat co-products are a source of many valuable nutrients which are required in human nutrition including protein, essential amino acids, vitamins (e.g., riboflavin, niacin, vitamin B6, vitamin B12 and pantothenic acid) and minerals (e.g., copper zinc, selenium, phosphorus and iron).

A comprehensive characterisation of the 88 Core Components and additional nutrients (vitamin K, biotin, pantothenic acid, choline, chloride and fatty acids) for heart, kidney, liver, lung, spleen, tongue, sinew, tendon, blood, tail and gelatine have been published on the NZFCD which is publicly accessible. Users of the NZFCD will include both consumers and industry and will allow them to explore how these venison products contribute to their diet or food formulation respectively.

In terms of contribution to the RDI of an average adult, the venison offal and co-products characterised were shown to be a source or good source of many macro- or micronutrients required in the human diet, at reasonable serving sizes (e.g., 100 g for wet products and 10 g for dried products). In particular, heart, kidney and liver were shown to provide the highest contributions to RDI for the broadest range of nutrients, followed by spleen, lung, tongue and blood. Although tendon, sinew and tail showed lesser contribution of key nutrients, they were still found to contribute to several micro- and macronutrients, whereas gelatine only meaningfully contributed to protein intake. Users of the NZFCD will be able to explore nutritional contribution to RDI in more depth when formulating new products.

A number of edible product categories were considered for adding value to venison offal and co-products including whole tissue products, processed and novel foods, soups, stocks and flavourings, and supplements. Most of the strategies considered are employed by the deer industry (or wider food processing industry) already for the sale of deer products (namely meat, offal, blood, gelatine and velvet), suggesting there is relevant knowledge and infrastructure in the industry which could support production of a wider suite of these product types prepared from different offal and co-products.

Recommendations

Most of the venison offal and co-products have current markets (e.g., offal export, pet food and small goods) therefore the aim is to diversify the types of markets and the overall value of the products. Key opportunities:

- **Minimally processed foods**: New product development of food to increase the quantity of offal consumed by Western consumers – e.g., ready-to- meals, meat-offal blends into wider range of small goods.
- **Premium ingredients:** New product development to enhance consumer eating experience – e.g., unique flavours derived from hydrolysed protein for stocks and flavourings.
- **Natural wellness products:** New product development of venison offal-derived protein isolates for use in personalised nutrition and health care products – e.g., naturally fortified ground meat, functional foods and supplements.

We expect that developing new minimally processed foods (ready-to meals) would pose the greatest challenge due to the substantial amount of upfront product development required to obtain meals with the desired eating experience. By contrast, the incorporation of offal into small goods such as sausage or chorizo, or the development of offal-enriched ground meat may increase their appeal to the average Western consumer and certainly present fewer economic and technical challenges to implement.

In the future, we expect to see a greater variety of natural wellness products (functional food or supplements) derived from meat and offal to meet the growing personalised nutrition and wellness market which addresses ageing (sarcopenia and cognitive decline), sustained energy and athletic recovery. Such products may include hydrolysed or fermented offal, as well as protein, vitamin and mineral isolates or foods including offal ingredients designed for optimal absorption. Further exploration of offal as a source of bioactive compounds for human health and wellness should be undertaken. Research areas could include the impact of processing, storage and cooking methods on the generation of bioactive compounds, as well as how consumption impacts overall health.

In the near-term, we recommend the following for venison offal and co-products:

- Meet the growing personalised nutrition and minimally processed foods trends by
    - Identifying markets where venison offal, extracts and protein isolates may be positively viewed for including in food and health products
    - Developing new products with proven health functionality e.g., bioactive peptides from hydrolysed proteins for human health
    - Developing new product offerings which can provide minimally or naturally processed offal into convenient formats

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Appendix 1: Methodology Sample Preparation

Samples and Sample Preparation

Table 5: Samples and sample preparation for each food type characterised for publication in the NZ Food Composition Database.

FoodID	Food Name	Sampling Details	Sample Preparation
M10074	Deer, offal, heart, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (20 and 21 October 2021) over the period from mid-October to mid-December 2021, frozen and packed in export packaging (individual plastic bag and waxed cardboard box). The 16 samples of deer heart were combined into a single composite sample for analysis.	Hearts were defrosted in 4 ºC chiller for 3 days. Density was determined for whole hearts, heart diced into 2.5 x 2.5cm cubes and sliced into 1.5 cm slices (in triplicate). The hearts were then homogenised through a mincer with a 3mm grinding plate.
M10075	Deer, offal, tongue, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (27 August 2021 and 6 September 2021) over the period from mid-August to mid-December 2021, frozen and packed in export packaging (bin liner and waxed cardboard box). The 30 samples of deer tongue were combined into a single composite sample for analysis.	Tongues were defrosted in 4 ºC chiller for 3 days. Density was determined for whole tongues, tongues diced into 2.5 x 2.5cm cubes and sliced into 1.5 cm slices (in triplicate). The tongues were then homogenised through a mincer with a 3mm grinding plate.
M10076	Deer, offal, liver, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (26 November 2021 and 7 December 2021) over the period from mid-October to mid-December 2021, frozen and packed in export packaging (bin liner and waxed cardboard box). The 31 samples of deer liver were combined into a single composite sample for analysis.	Livers were defrosted in 4 ºC chiller for 3 days. Density was determined for halved livers, livers diced into 2.5 x 2.5cm cubes and sliced into 1.5 cm slices (in triplicate). The livers were then homogenised through a mincer with a 3mm grinding plate.
M10077	Deer, offal, lung, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the	Lungs were defrosted in 4 ºC chiller for 3 days. Density was determined for single lungs, lungs diced into 2.5 x 2.5cm

		South Island, (26 November 2021 and 7 December) over the period from mid-November to mid-December 2021, frozen and packed in export packaging (bin liner and waxed cardboard box). The 29 samples of deer lung were combined into a single composite sample for analysis.	cubes and sliced into 1.5 cm slices (in triplicate). The lungs were then homogenised through a mincer with a 3mm grinding plate.
M10078	Deer, offal, spleen, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (26 November 2021) over the period from mid-October to mid-December 2021, frozen and packed in export packaging (bin liner and waxed cardboard box). The 22 samples of deer spleen were combined into a single composite sample for analysis.	Spleens were defrosted in 4 ^{o}C chiller for 3 days. Density was determined for whole spleens, spleens diced into 2.5 x 2.5cm cubes and sliced into 1.5 cm slices (in triplicate). The spleens were then homogenised through a mincer with a 3mm grinding plate.
M10079	Deer, offal, kidney, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (26 November 2021) over the period from mid-October to mid-December 2021, frozen and packed in export packaging (bin liner and waxed cardboard box). The 55 samples of deer kidney were combined into a single composite sample for analysis.	Kidneys were defrosted in 4 ^{o}C chiller for 3 days. Density was determined for whole single kidneys, kidneys diced into 2.5 x 2.5cm cubes and sliced into 1.5 cm slices (in triplicate). The kidneys were then homogenised through a mincer with a 3mm grinding plate.
M10081	Deer, meat, dried tail, powdered	The item was selected by members of the Deer Industry New Zealand. The composite sample was obtained from an ingredient processor in the South Island, over the period from mid-November to mid-December 2021, dried and packed in export packaging (sealed plastic bag and waxed cardboard box). The composite sample of dried deer tail was prepared from a day's production line for analysis.	Deer tail powder was received already dried and finely ground. Density of deer powder was determined (in triplicate).
M10083	Deer, offal, tendon, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (18, 19 and 24 November 2021) over the period from mid-November to mid-December 2021, frozen and	Tendons were defrosted in 4 ^{o}C chiller for 3 days. Density was determined for whole single tendons, tendons sliced to lengths of 15 cm and 5 cm (in triplicate). The tendons were then homogenised through a mincer with a 3mm grinding plate.

		packed in export packaging (bin liner and waxed cardboard box). The 40 samples of deer sinew were combined into a single composite sample for analysis.	
M10084	Deer, offal, sinew, raw	The item was selected by members of the Deer Industry New Zealand. The samples were obtained from an abattoir in the South Island, (26 November 2021) over the period from mid-November to mid-December 2021, frozen and packed in export packaging (bin liner and waxed cardboard box). The 35 samples of deer tendon were combined into a single composite sample for analysis.	Sinews were defrosted in 4 ºC chiller for 3 days, and the bony end sliced off and discarded. Density was determined for trimmed single pieces of sinew, sinews sliced to lengths of 15 cm and 5 cm (in triplicate). The sinews were then homogenised through a mincer with a 3mm grinding plate.
M10085	Deer, offal, gelatine, raw	The item was selected by members of the Deer Industry New Zealand. The composite sample was obtained from an ingredient processor in the South Island, over the period from mid-November to mid-December 2021, dried and packed in export packaging (sealed plastic bag and waxed cardboard box). The composite sample of deer gelatine was prepared from a day's production line for analysis.	Deer gelatine powder was received already dried and finely ground. Density of deer gelatine powder was determined (in triplicate).
M10086	Deer, offal, blood, raw	The item was selected by members of the Deer Industry New Zealand. The composite sample was obtained from an abattoir in the South Island, (26 November 2021) over the period from mid-November to mid-December 2021, with citrate added, frozen and packed in export packaging (sealed plastic bag and waxed cardboard box). The composite sample of deer blood was prepared from a day's production line for analysis.	Blood was defrosted in 4 ºC chiller for 8 days and homogenised using an overhead paint mixer. Density was determined for blood (in triplicate).

Determination of Average Offal Weights

Each individual offal or co-product was weighted (10 replicates) and the result averaged to obtain the average weight of each product type.

Determination of Density Measurements

Whole tissue density measurements

Entire individual offals were placed in a measuring cup and weighed, the balance was then tared, and water added to fill to the top of the mark before reweighing (Figure 6). The volume of water was determined from the weight of water and its density at 22ºC (0.99777 g/cm^3), which was used to determine the volume of the offal (Eqn 1). The volume of the offal and its weight were used to determine its density (Eqn 2). All density results were obtained from triplicate measures.

Eqn 1: $Volume\ of\ Offal = V(Container) - V(Water)$

Eqn 2: $Density\ of\ Offal = \frac{m(Offal)}{V(Offal)}$

Figure 6: Example of whole offal density measurements (liver halves).

Cubed and sliced offal density measurements

Offals diced into 2.5 x 2.5 cm cubes or 1.5 cm thick slices were placed in a measuring cylinder up to the mark and weight (Figure 7). Tendons and sinews were prepared as 15 cm or 5 cm long slices. Density was calculated by dividing the offal volume by the offal weight Eqn 3. All density results were obtained from single measures.

Eqn 3: $Density\ of\ Offal = \frac{m(Offal)}{V(Offal)}$

Figure 7: Example of cubed (left) and sliced (right) density measurement for offals (kidneys).

Powdered and fluid offal density measurements

The dried powder sample (tail and gelatine) densities were determined by the weight of powder in teaspoon (5 mL), and the fluid sample (blood) density was determined by the weight of fluid in a cup (250 mL) (Figure 8). Density was calculated by dividing the offal volume by the offal weight Eqn 3. All density results were obtained from triplicate measures.

Figure 8: Example of density measurement for powdered and fluid offals (blood).

Appendix 2: Results for Offal Weights and Densities

Table 6: Weight in grams of individual co-products and averages.

Replicate	Heart	Tongue	Liver (halved)	Lung	Spleen	Kidney	Tendon	Sinew (trimmed)
1	966	234	750	1108	214	112	30	68
2	956	188	856	760	212	116	24	78
3	926	184	956	784	262	110	26	52
4	1236	216	688	630	224	112	28	44
5	874	194	704	978	268	128	28	46
6	1062	196	678	640	296	134	20	48
7	952	246	386	498	246	124	20	46
8	914	222	956	780	310	120	18	74
9	1020	168	752	862	288	106	24	76
10	930	192	888	1130	200	118	22	52
Average	**984**	**204**	**762**	**817**	**252**	**118**	**24**	**58**

Table 7: Density measures for offal products, determined from triplicate measures.

FoodID and Food Name	CSM	Measure (g)	Density (g/cm^3)
M10074 Heart, raw	1 heart	952	1.03
	1 cup diced (2.5 cm cubes) (250 mL)	178	0.712
	1 cup sliced (1.5 cm sliced) (250 mL)	152	0.608
M10075 Tongue, raw	1 tongue	208	1.07
	1 cup diced (2.5 cm cubes) (250 mL)	170	0.68
	1 cup sliced (1.5 cm sliced) (250 mL)	159	0.636
M10076 Liver, raw	1/2 liver	704	0.96
	1 cup diced (2.5 cm cubes) (250 mL)	167	0.668
	1 cup sliced (1.5 cm sliced) (250 mL)	185	0.74
M10077 Lung, raw	1 lung	469	0.65
	1 cup diced (2.5 cm cubes) (250 mL)	122	0.488
	1 cup sliced (1.5 cm sliced) (250 mL)	111	0.444
M10078 Spleen, raw	1 spleen	287	0.82
	1 cup diced (2.5 cm cubes) (250 mL)	201	0.804
	1 cup sliced (1.5 cm sliced) (250 mL)	194	0.776
M10079 Kidney, raw	1 kidney	125	0.73
	1 cup diced (2.5 cm cubes) (250 mL)	185	0.74
	1 cup sliced (1.5 cm sliced) (250 mL)	197	0.788
M10081 Tail, dried powdered	1 tsp (5 mL)	2.31	0.479
M10083 Tendon, raw	1 cup cut to 15 cm pieces (250 mL)	134	0.536
	1 cup cut to 5 cm pieces (250 mL)	148	0.592
M10084 Sinew, raw	1 cup cut to 15 cm pieces (250 mL)	151	0.604
	1 cup cut to 5 cm pieces (250 mL)	156	0.624
M10085 Gelatine, dried powered	1 tsp (5 mL)	3.48	0.695
M10086 Blood, raw	1 cup (250 mL)	256	1.024

Appendix 3: Methodology Nutritional Analysis

The nutrients characterised in this study are listed in Table 8 and were analysed using standardised (in-house) and published methods routinely used by the NZFCD, e.g., Association of Official Analytical Chemists (AOAC) methods [43]. The laboratories that conducted the food component analyses are accredited by independent science-based organisations with the authority to grant accreditation: International Accreditation New Zealand [44] and the National Association of Testing Authorities, Australia [45]. Accredited laboratories also have their own quality assurance programmes in place. The laboratories used were: AsureQuality Limited (Auckland, New Zealand); Nutrition Laboratory, Massey University (Palmerston North, New Zealand); RJ Hill Laboratories Limited (Hill Laboratories; Hamilton, New Zealand); The National Measurement Institute (NMI), AgResearch (Palmerston North, New Zealand) and Path West Laboratories (Perth, Australia).

Table 8: Components analysed in the deer offal samples.

Nutrient	Laboratory	Method	Reference
Proximates			
Water (moisture)	AsureQuality Limited	AOAC 950.46B	
Ash	AsureQuality Limited	AOAC 920.153	
Nitrogen (for protein)	AsureQuality Limited	via Kjeldahl	
Fat	Massey University	AOAC 991.36; tail & gelatine AOAC 922.06	
Minerals			
Calcium, iron, potassium, magnesium, sodium and phosphorus	Hill Laboratories	Biological materials digestion then ICP–OES	Mendham et al. 2000 [46]
Copper, manganese and zinc	Hill Laboratories	Biological materials digestion then ICP–MS	Martin et al. 1994 [47]
Iodine and selenium	Hill Laboratories	TMAH digestion followed by ICP–MS	Fecher et al. 1998 [48]
Vitamins			
Biotin	Eurofins	J AOAC vol 93 no. 5 - 2010	
Carotenoids (α- and β-carotene) for vitamin A	AsureQuality Limited	AOAC 2016.13 (Modified)	
Folate, total	National Measurement Institute, Australia	Tri-enzyme microbiological bioassay (Path West Method RPH01161)	Based on DeVries et al. 2005 [49]
Niacin (B3), preformed	AsureQuality Limited	AOAC 2015.14	
Pantothenic acid (B5)	Eurofins	AOAC 2012.16	
Riboflavin (B2)	AsureQuality Limited	AOAC 2015.14	
Thiamin (B1)	AsureQuality Limited	AOAC 2015.14	
Vitamin A (retinol)	AsureQuality Limited	EN 12823-1:2000, COST91	European Committee for Standardisation 2000 [50]
Vitamin B6	AsureQuality Limited	AOAC 2015.14	

Vitamin B12	Eurofins	AOAC 952.20	
Vitamin C	AsureQuality Limited	AOAC 2012.22	
Vitamin D3	Eurofins	EN 12821:2009	European Committee for Standardisation 2009 [51]
Vitamin E as tocopherols (α-, β-, γ- and δ-)[b]	AsureQuality Limited	HPLC – COST 91	Brubacher et al. 1985 [52]
Vitamin K	AsureQuality Limited	AOAC 2015.09 (modified)	
Other			
Fatty acids	Massey University	GLC – in-house method	Based on Sukhija & Palmquist 1988 [53]
Amino acids	AgResearch	Acid stable amino acids by acid hydrolysis – AOAC 994.12 (modified) Sulphur amino acids by performic acid oxidation – AOAC 994.12 (modified) Tryptophan by alkaline hydrolysis AOAC 988.15 (modified)	
Cholesterol	AsureQuality Limited	AOAC 933.08, 970.50, 970.51	
Choline	Eurofins	AOAC Vol 91, 2008	Andrieux et al. 2008 [54]
Chloride	AsureQuality Limited	In house method	

Abbreviations: AOAC = Association of Official Analytical Chemists; GLC = gas-liquid chromatography; HPLC = high performance liquid chromatography; ICP–MS = inductively coupled plasma–mass spectrometry; ICP–OES = inductively coupled plasma–optical emission spectrometry; TMAH = tetramethylammonium hydroxide.

Other component values, including energy, carbohydrates, vitamin A, vitamin E and total fatty acids were derived from the analytical values by calculation using the formulae outlined in Table 9. Calculations were performed in FoodCASE. The calculation methods for these components are also described in more detail in the current FOODfiles manual [55] and Food Standards Australia New Zealand (FSANZ) requirements [6, 8]. Note, some of the required components for the calculation methods were not analysed in this study since they are not present in offal. As an example, alcohol (ethanol) is one of the required components in energy calculation methods and was presumed to be zero.

Table 9: Calculation methods used for some of the nutritional components of deer offal and co-products.

Food component (unit)	Calculation method
Energy	
Energy, total metabolisable, available carbohydrate, FSANZ (kJ)	Protein (g) x 17 + Fat (g) x 37 + Available carbohydrate by weight (g) x 17 + Dietary fibre x 8
Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	Energy, total metabolisable, available carbohydrate, FSANZ (kJ)/4.18
Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	Protein (g) x 17 + Fat (g) x 37 + Carbohydrate by difference (g) x 17 + Dietary fibre (g) x 8
Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)/4.18

Proximates	
Proximates, total	Sum of ash, protein, total fat, water, dietary fibre, alcohol and available carbohydrate by weight
Sugars, total	Sum of measured mono- and disaccharides
Available carbohydrate by difference, FSANZ	100 − [Water (g) + Protein (g) + Fat (g)+ Ash (g) + Dietary fibre (g)]
Available carbohydrate, FSANZ	Sugar total (g) + Starch total (g)
Protein	Nitrogen * protein conversion factor[b]
Vitamins	
Niacin, equivalents total (mg)	Niacin, preformed + niacin equivalent from tryptophan[a]
Tocopherols IU to mg	Individual tocopherols x 0.67
Vitamin A, retinol equivalents	Retinol + beta-carotene equivalent x 0.167
Vitamin E, alpha-tocopherol equivalents (mg)	Alpha-tocopherol (mg) + Beta-tocopherol (mg) x 0.4 + Delta-tocopherol (mg) x 0.01 + Gamma-tocopherol (mg) x 0.1

[a] Conversion factor for niacin equivalents of tryptophan 0.017 g/g.
[b] A generic nitrogen to protein conversion factor of 6.25 was used for all offal items except gelatine (M10085). For gelatine specific factor 5.55 was used (Greenfield & Southgate 2003).
Abbreviations: FSANZ = Food Standards Australia New Zealand; IU = international units.

Fatty acids data are expressed as both g/100 g of food and as a percentage of the total fatty acid content. Individual fatty acid (g/100 g food) values in food are derived from the value of each individual fatty acid (g/100 g TFA2) using the following equation. Individual fatty acid (g⁄100 g food) = (Individual fatty acid (g/100 g TFA) x FACID (g⁄100 g food)/100. The individual fatty acids are listed in Table 10 with the NZFCD component names, systematic names, trivial names and abbreviations where appropriate [56-58]. Fatty acids, total saturated is the sum of all the individual saturated fatty acids listed in Table 10. Fatty acids, total monounsaturated is the sum of undifferentiated individual fatty acids listed in Table 10. The undifferentiated fatty acid, e.g., fatty acid 18:1 omega-9, is calculated from the sum of its differentiated isomers, i.e. cis and trans. Fatty acids, total polyunsaturated is the sum of undifferentiated individual fatty acids listed in Table 10. Fatty acids, total omega-3 polyunsaturated and Fatty acids, total omega-6 polyunsaturated are the sums of the undifferentiated omega-3 fatty acid and undifferentiated omega-6 fatty acid in Table 10, respectively. Fatty acids, total trans is the sum of the percentage of individual trans fatty acids in Table 10.

Table 10: Details of the fatty acids reported in the deer offal samples.

Fatty acid name	Systematic name	Trivial name	Abbreviation
Monounsaturated			
Fatty acid 14:1	tetradecenoic	myristoleic	
Fatty acid 14:1 omega-5	tetradec-9-enoic	myristoleic	
Fatty acid 15:1	pentadecenoic	oncobic	
Fatty acid 16:1 undifferentiated	hexadecenoic	palmitoleic	
Fatty acid cis 16:1	cis-hexadecenoic	cis-palmitoleic	
Fatty acid 17:1	heptadecenoic	civetic	
Fatty acid 18:1 undifferentiated	octadecenoic		
Fatty acid cis 18:1	cis-octadecenoic		
Fatty acid trans 18:1	trans-octadecenoic		

Fatty acid 18:1 omega-7 undifferentiated	octadec-11-enoic	vaccenic	
Fatty acid cis.18:1 omega-7	cis-octadec-11-enoic	cis-vaccenic	
Fatty acid trans 18:1 omega-7	trans-octadec-11-enoic	trans-vaccenic	
Fatty acid 18:1 omega-9 undifferentiated	octadec-9-enoic		
Fatty acid cis 18:1 omega-9	cis-octadec-9-enoic	elaidoic, (cis-)oleic	
Fatty acid trans 18:1 omega-9	trans-octadec-9-enoic	elaidic, trans-oleic	
Fatty acid 20:1 undifferentiated	eicosenoic		
Fatty acid 20:1 omega-9	eicos-11-enoic	gondoic	
Fatty acid 22:1 undifferentiated	docosenoic		
Fatty acid 22:1 omega-9	docos-13-enoic	erucic	
Fatty acid 24:1	tetracosenoic	nervonic	
Polyunsaturated			
Fatty acid 18:2 undifferentiated	octadecadienoic		
Fatty acid cis 18:2	cis-octadecadienoic		
Fatty acid trans 18:2	trans-octadecadienoic		
Fatty acid 18:2 omega-6 undifferentiated	octadeca-9,11-dienoic		
Fatty acid cis,cis 18:2 omega-6	cis,cis-octadeca-9,12-dienoic	linoleic	
Fatty acids cis,trans 18:2 omega-9, 11	cis,trans-octadeca-9,11-dienoic	conjugated linoleic, rumenic	CLA
Fatty acid trans 18:2 omega-6	trans-octadeca-9,12-dienoic	linoeladic acid	
Fatty acid 18:3 undifferentiated	octadecatrienoic	linolenic	
Fatty acid 18:3 omega-3	all-cis-octadeca-9,12,15-trienoic	α-linolenic	ALA
Fatty acid 18:3 omega-6	all-cis-octadeca-6,9,12-trienoic	γ-linolenic	GLA
Fatty acid 20:2	eicosadienoic		
Fatty acid 20:2 omega-6	all-*cis*-eicosa-11,14-dienoic	eicosadienoic	
Fatty acid 20:3 undifferentiated	eicosatrienoic		
Fatty acid 20:3 omega-3	all-*cis*-eicosa-11,14,17-trienoic	eicosatrienoic	ETE
Fatty acid 20:3 omega-6	all-*cis*-eicosa-8,11,14-trienoic	dihomo-γ-linolenic	DHLA
Fatty acid 20:4 undifferentiated	eicosatetraenoic		
Fatty acid 20:4 omega-6	all-*cis*-eicosa-5,8,11,14-tetraenoic	arachidonic	AA
Fatty acid 20:5	eicosapentaenoic		
Fatty acid 20:5 omega-3	all-*cis*-eicosa-5,8,11,14,17-pentaenoic	timnodonic	EPA
Fatty acid 22:2	docosadienoic		
Fatty acid 22:2 omega-6	all-*cis*-docosa-13,22-dienoic	docosadienoic	

Fatty acid 22:5 undifferentiated	docosapentaenoic		
Fatty acid 22:5 omega-3	all-*cis*-docosa-7,10,13,22,19-pentaenoic	clupanodonic	DPA
Fatty acid 22:6	docosahexaenoic		
Fatty acid 22:6 omega-3	all-*cis*-docosa-4,7,10,13,22,19-hexaenoic	cervonic	DHA
Saturated			
Fatty acid 6:0	hexanoic	caproic	
Fatty acid 8:0	octanoic	caprylic	
Fatty acid 12:0	dodecanoic	lauric	
Fatty acid 13:0	tridecanoic	tridecyclic	
Fatty acid 14:0	tetradecanoic	myristic	
Fatty acid 16:0	hexadecanoic	palmitic	
Fatty acid 17:0	heptadecanoic	margaric	
Fatty acid 18:0	octadecanoic	stearic	
Fatty acid 20:0	eicosanoic	arachidic	
Fatty acid 21:0	heneicosanoic	heneicosylic	
Fatty acid 22:0	docosanoic	behenic	
Fatty acid 23:0	tricosanoic	tricosylic	
Fatty acid 24:0	tetracosanoic	lignoceric	

Appendix 4: Results Nutritional Analysis

Table 11: Nutrient results for the venison offal and co-products samples.

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Alanine	mg/100 g	1130	868	1080	1240	1350	860	4760	2870	2830	8700	1770
Alcohol	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Alpha-carotene	µg/100 g	0	0	0	0	0	0	0	0	0	0	0
Alpha-tocopherol	mg/100 g	0	0	0	0	0	0	0.15	0	0	0	0
Arginine	mg/100 g	1080	881	1090	1030	1050	827	4670	2500	2460	7250	947
Ash	g/100 g	1.1	0.8	2.6	1.3	1.3	1.3	5.2	0.4	0.7	0.5	0.9
Aspartic acid	mg/100 g	1590	1230	1700	1460	1530	1330	7830	1910	1900	5410	2370
Available carbohydrate by difference	g/100 g	0.36	0.35	0.54	0	0	0.74	0	0	0	6.19	0
Available carbohydrate, FSANZ	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Available carbohydrates by weight	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Available carbohydrates in monosaccharide equivalent	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Beta-carotene	µg/100 g	0	0	16	0	0	0	0	0	0	0	0
Beta-carotene equivalents	µg/100 g	0	0	16	0	0	0	0	0	0	0	0
Beta-tocopherol	mg/100 g	0	0	0	0	0	0	0	0	0	0	0
Biotin	µg/100 g	3	0	110	3.2	1.8	78	9.4	0	0	0	0

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Caffeine	mg/100 g	0	0	0	0	0	0	0	0	0	0	0
Calcium	mg/100 g	5	5	4	9	5	7	1500	8	14	115	5
Carbohydrate by difference, FSANZ	g/100 g	0.36	0.35	0.54	0	0	0.74	0	0	0	6.19	0
Chloride	mg/100 g	110	94	91	203	147	247	401	168	232	58	251
Cholecalciferol (Vitamin D3)	µg/100 g	0	0	0	0	0	0.38	0	0	8.5	0	0.6
Cholesterol	mg/100 g	100	90	261	422	392	436	620	49	81	0	182
Choline	mg/100 g	107	67.2	316	170	93.2	192	249	9.81	6.22	0.765	2.36
Copper	mg/100 g	0.35	0.122	0.48	0.42	0.078	0.57	0.37	0.051	0.022	0.21	0.058
Cystine	mg/100 g	199	191	299	224	270	241	1010	72	57	42	182
Delta-tocopherol	mg/100 g	0	0	0	0	0	0	0	0	0	0	0
Dietary folate equivalents	µg/100 g	0	0	480	8	6	51	20	9	8	21	4
Disaccharides, total	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Disaccharides, total (monosaccharide equivalents)	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Dry matter	g/100 g	23.9	35.8	27.6	21.7	22	20.4	96.8	32.1	31.1	94.3	21.7
Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	kcal/100 g	113	237	122	95	92	86	439	161	151	358	90
Energy, total metabolisable, available	kJ/100 g	474	993	512	396	386	360	1840	673	630	1500	378

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
carbohydrate, FSANZ (kJ)												
Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	kcal/100 g	115	239	125	95	92	89	439	161	151	383	90
Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	kJ/100 g	480	999	521	396	386	372	1840	673	630	1600	378
Energy, total metabolisable (kcal)	kcal/100 g	113	240	122	94	91	85	436	159	149	352	89
Energy, total metabolisable (kcal, including dietary fibre)	kcal/100 g	113	240	122	94	91	85	436	159	149	352	89
Energy, total metabolisable (kJ)	kJ/100 g	474	993	512	396	386	360	1840	673	630	1500	378
Energy, total metabolisable (kJ, including dietary fibre)	kJ/100 g	474	993	512	396	386	360	1840	673	630	1500	378
Ergocalciferol (Vitamin D2)	µg/100 g	0	0	0	0	0	0	0	0	0	0	0
Fat, total	g/100 g	4.64	20.2	4.79	2.06	1.42	2.38	12.7	1.76	1.06	0.34	0.1
Fatty acid 10:0	g/100 g	0.008	0.008	0.025	0.017	0.045	0.044	0.18	0.004	0.005	0	0.002
Fatty acid 10:0 (/100 g TFA)	g/100 g TFA	0.188	0.045	0.586	1.21	4.26	2.06	1.94	0.236	0.723	0	1.58
Fatty acid 12:0	g/100 g	0.021	0.044	0.008	0.002	0.002	0.003	0.036	0.003	0.003	0.004	0.002

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid 12:0 (/100 g TFA)	g/100 g TFA	0.525	0.241	0.186	0.145	0.155	0.126	0.387	0.188	0.407	7.02	1.58
Fatty acid 13:0	g/100 g	0.003	0.012	0.002	0	0	0.001	0.003	0	0	0	0
Fatty acid 13:0 (/100 g TFA)	g/100 g TFA	0.067	0.064	0.043	0	0.022	0.035	0.036	0	0	0	0
Fatty acid 14:0	g/100 g	0.286	0.856	0.126	0.028	0.012	0.042	0.507	0.071	0.02	0.004	0.001
Fatty acid 14:0 (/100 g TFA)	g/100 g TFA	7.07	4.73	3	1.97	1.18	1.98	5.48	4.28	2.85	7.02	0.592
Fatty acid 14:1	g/100 g	0.02	0.131	0.014	0.001	0.001	0.002	0.268	0.131	0.045	0.002	0
Fatty acid 14:1 (/100 g TFA)	g/100 g TFA	0.485	0.724	0.329	0.081	0.133	0.111	2.9	7.83	6.56	3.51	0
Fatty acid 14:1 omega-5	g/100 g	0.02	0.131	0.014	0.001	0.001	0.002	0.268	0.131	0.045	0.002	0
Fatty acid 14:1 omega-5 (/100 g TFA)	g/100 g TFA	0.485	0.724	0.329	0.081	0.133	0.111	2.9	7.83	6.56	3.51	0
Fatty acid 15:1	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Fatty acid 15:1 (/100 g TFA)	g/100 g TFA	0	0	0	0	0	0	0	0	0	0	0
Fatty acid 16:0	g/100 g	1.23	5.09	1.14	0.372	0.192	0.461	2.47	0.344	0.118	0.018	0.017
Fatty acid 16:0 (/100 g TFA)	g/100 g TFA	30.3	28.1	27	26.3	18.4	21.7	26.7	20.6	17	31.6	15
Fatty acid 16:1	g/100 g	0.082	0.786	0.119	0.021	0.011	0.025	1.04	0.542	0.198	0.005	0.002
Fatty acid 16:1 (/100 g TFA)	g/100 g TFA	2.02	4.34	2.83	1.47	1.02	1.17	11.2	32.5	28.5	8.77	1.38
Fatty acid 17:0	g/100 g	0.051	0.3	0.052	0.018	0.013	0.025	0.104	0.006	0.005	0.003	0.004
Fatty acid 17:0 (/100 g TFA)	g/100 g TFA	1.26	1.66	1.23	1.24	1.2	1.19	1.12	0.333	0.723	5.26	3.35
Fatty acid 17:1	g/100 g	0	0.002	0.001	0	0	0	0	0	0	0	0

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid 17:1 (/100 g TFA)	g/100 g TFA	0	0.01	0.014	0	0	0.01	0	0	0.045	0	0
Fatty acid 18:0	g/100 g	1.05	4.06	0.969	0.229	0.215	0.446	1.13	0.046	0.033	0.01	0.018
Fatty acid 18:0 (/100 g TFA)	g/100 g TFA	26	22.4	23	16.2	20.5	21	12.2	2.78	4.7	17.5	15.6
Fatty acid 18:1	g/100 g	0.578	5.42	0.547	0.289	0.127	0.254	2.73	0.445	0.201	0.01	0.033
Fatty acid 18:1 (/100 g TFA)	g/100 g TFA	14.3	30	13	20.4	12.2	12	29.6	26.7	29	17.5	29.2
Fatty acid 18:1 omega-7	g/100 g	0.134	0.623	0.14	0.03	0.022	0.058	0.42	0.184	0.082	0.002	0.003
Fatty acid 18:1 omega-7 (/100 g TFA)	g/100 g TFA	3.3	3.45	3.33	2.15	2.06	2.75	4.54	11	11.8	3.51	2.76
Fatty acid 18:1 omega-9	g/100 g	0.444	4.8	0.407	0.259	0.106	0.196	2.31	0.261	0.119	0.008	0.03
Fatty acid 18:1 omega-9 (/100 g TFA)	g/100 g TFA	11	26.5	9.65	18.3	10.1	9.26	25	15.6	17.2	14	26.4
Fatty acid 18:2	g/100 g	0.305	0.616	0.243	0.06	0.079	0.242	0.3	0.023	0.018	0	0.014
Fatty acid 18:2 (/100 g TFA)	g/100 g TFA	7.53	3.4	5.78	4.2	7.52	11.4	3.25	1.36	2.53	0	12.4
Fatty acid 18:2 omega-6	g/100 g	0.305	0.616	0.243	0.06	0.079	0.242	0.3	0.023	0.018	0	0.014
Fatty acid 18:2 omega-6 (/100 g TFA)	g/100 g TFA	7.53	3.4	5.78	4.2	7.52	11.4	3.25	1.36	2.53	0	12.4
Fatty acid 18:3	g/100 g	0.106	0.392	0.15	0.027	0.05	0.08	0.192	0.013	0.007	0	0.004
Fatty acid 18:3 (/100 g TFA)	g/100 g TFA	2.62	2.17	3.55	1.87	4.75	3.76	2.08	0.805	0.995	0	3.16

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid 18:3 omega-3	g/100 g	0.103	0.388	0.126	0.014	0.015	0.051	0.046	0.011	0.004	0	0.003
Fatty acid 18:3 omega-3 (/100 g TFA)	g/100 g TFA	2.54	2.15	3	1.02	1.44	2.41	0.495	0.651	0.542	0	2.56
Fatty acid 18:3 omega-6	g/100 g	0.003	0.004	0.023	0.012	0.035	0.029	0.146	0.003	0.003	0	0.001
Fatty acid 18:3 omega-6 (/100 g TFA)	g/100 g TFA	0.081	0.024	0.558	0.857	3.31	1.35	1.58	0.154	0.452	0	0.592
Fatty acid 20:0	g/100 g	0.01	0.028	0.004	0.023	0.006	0.009	0.022	0.001	0	0	0
Fatty acid 20:0 (/100 g TFA)	g/100 g TFA	0.236	0.157	0.086	1.6	0.577	0.408	0.242	0.048	0	0	0
Fatty acid 20:1	g/100 g	0.003	0.036	0.006	0.005	0.003	0.003	0.021	0.003	0.003	0	0
Fatty acid 20:1 (/100 g TFA)	g/100 g TFA	0.074	0.202	0.143	0.372	0.266	0.132	0.23	0.181	0.362	0	0
Fatty acid 20:1 omega-9	g/100 g	0.003	0.036	0.006	0.005	0.003	0.003	0.021	0.003	0.003	0	0
Fatty acid 20:1 omega-9 (/100 g TFA)	g/100 g TFA	0.074	0.202	0.143	0.372	0.266	0.132	0.23	0.181	0.362	0	0
Fatty acid 20:2	g/100 g	0.002	0.01	0.005	0.002	0.002	0.006	0.047	0	0	0	0
Fatty acid 20:2 (/100 g TFA)	g/100 g TFA	0.061	0.054	0.122	0.162	0.178	0.278	0.507	0.016	0	0	0
Fatty acid 20:2 omega-6	g/100 g	0.002	0.01	0.005	0.002	0.002	0.006	0.047	0	0	0	0
Fatty acid 20:2 omega-6 (/100 g TFA)	g/100 g TFA	0.061	0.054	0.122	0.162	0.178	0.278	0.507	0.016	0	0	0
Fatty acid 20:3	g/100 g	0.015	0.033	0.048	0.02	0.012	0.026	0.016	0.002	0.002	0	0

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid 20:3 (/100 g TFA)	g/100 g TFA	0.37	0.183	1.14	1.39	1.18	1.25	0.169	0.117	0.316	0	0
Fatty acid 20:3 omega-3	g/100 g	0.004	0.021	0.011	0.003	0.002	0.012	0.009	0.001	0	0	0
Fatty acid 20:3 omega-3 (/100 g TFA)	g/100 g TFA	0.094	0.115	0.257	0.178	0.178	0.578	0.097	0.039	0	0	0
Fatty acid 20:3 omega-6	g/100 g	0.011	0.012	0.037	0.017	0.01	0.014	0.007	0.001	0.002	0	0
Fatty acid 20:3 omega-6 (/100 g TFA)	g/100 g TFA	0.276	0.068	0.88	1.21	0.998	0.668	0.072	0.078	0.316	0	0
Fatty acid 20:4	g/100 g	0.112	0.089	0.231	0.113	0.107	0.212	0.029	0.013	0.014	0	0.004
Fatty acid 20:4 (/100 g TFA)	g/100 g TFA	2.78	0.49	5.49	8	10.3	10	0.314	0.761	1.99	0	3.75
Fatty acid 20:4 omega-6	g/100 g	0.112	0.089	0.231	0.113	0.107	0.212	0.029	0.013	0.014	0	0.004
Fatty acid 20:4 omega-6 (/100 g TFA)	g/100 g TFA	2.78	0.49	5.49	8	10.3	10	0.314	0.761	1.99	0	3.75
Fatty acid 20:5	g/100 g	0.053	0.023	0.096	0.034	0.032	0.084	0.007	0.004	0.003	0	0.002
Fatty acid 20:5 (/100 g TFA)	g/100 g TFA	1.32	0.13	2.27	2.42	3.04	3.95	0.072	0.268	0.452	0	1.58
Fatty acid 20:5 omega-3	g/100 g	0.053	0.023	0.096	0.034	0.032	0.084	0.007	0.004	0.003	0	0.002
Fatty acid 20:5 omega-3 (/100 g TFA)	g/100 g TFA	1.32	0.13	2.27	2.42	3.04	3.95	0.072	0.268	0.452	0	1.58
Fatty acid 21:0	g/100 g	0.001	0.002	0.001	0.002	0.001	0.001	0.003	0	0	0	0
Fatty acid 21:0 (/100 g TFA)	g/100 g TFA	0.034	0.012	0.014	0.162	0.111	0.033	0.036	0	0	0	0

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid 22:0	g/100 g	0.009	0.013	0.012	0.028	0.011	0.019	0.035	0.002	0.003	0	0.002
Fatty acid 22:0 (/100 g TFA)	g/100 g TFA	0.222	0.071	0.279	1.99	1.07	0.912	0.374	0.129	0.407	0	1.78
Fatty acid 22:1	g/100 g	0	0	0	0.002	0	0	0.01	0	0	0	0
Fatty acid 22:1 (/100 g TFA)	g/100 g TFA	0	0	0	0.129	0.044	0.021	0.109	0	0	0	0
Fatty acid 22:1 omega-9	g/100 g	0	0	0	0.002	0	0	0.01	0	0	0	0
Fatty acid 22:1 omega-9 (/100 g TFA)	g/100 g TFA	0	0	0	0.129	0.044	0.021	0.109	0	0	0	0
Fatty acid 22:2	g/100 g	0.002	0.001	0	0	0	0	0	0	0	0	0
Fatty acid 22:2 (/100 g TFA)	g/100 g TFA	0.054	0.007	0	0	0	0.02	0	0	0	0	0
Fatty acid 22:2 omega-6	g/100 g	0.002	0.001	0	0	0	0	0	0	0	0	0
Fatty acid 22:2 omega-6 (/100 g TFA)	g/100 g TFA	0.054	0.007	0	0	0	0.02	0	0	0	0	0
Fatty acid 22:5	g/100 g	0.061	0.103	0.287	0.08	0.089	0.075	0.023	0.008	0.008	0	0.002
Fatty acid 22:5 (/100 g TFA)	g/100 g TFA	1.5	0.571	6.82	5.67	8.5	3.52	0.254	0.47	1.22	0	1.97
Fatty acid 22:5 omega-3	g/100 g	0.061	0.103	0.287	0.08	0.089	0.075	0.023	0.008	0.008	0	0.002
Fatty acid 22:5 omega-3 (/100 g TFA)	g/100 g TFA	1.5	0.571	6.82	5.67	8.5	3.52	0.254	0.47	1.22	0	1.97
Fatty acid 22:6	g/100 g	0.024	0.017	0.102	0.011	0.012	0.028	0.002	0.001	0.002	0	0
Fatty acid 22:6 (/100 g TFA)	g/100 g TFA	0.592	0.092	2.43	0.743	1.15	1.33	0.024	0.054	0.226	0	0

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid 22:6 omega-3	g/100 g	0.024	0.017	0.102	0.011	0.012	0.028	0.002	0.001	0.002	0	0
Fatty acid 22:6 omega-3 (/100 g TFA)	g/100 g TFA	0.592	0.092	2.43	0.743	1.15	1.33	0.024	0.054	0.226	0	0
Fatty acid 23:0	g/100 g	0.005	0.005	0.013	0.006	0.006	0.007	0.017	0	0	0	0.001
Fatty acid 23:0 (/100 g TFA)	g/100 g TFA	0.128	0.026	0.3	0.42	0.555	0.351	0.181	0.017	0	0	0.592
Fatty acid 24:0	g/100 g	0.004	0.007	0.009	0.019	0.011	0.016	0.028	0.002	0.003	0	0.006
Fatty acid 24:0 (/100 g TFA)	g/100 g TFA	0.101	0.037	0.215	1.31	1.04	0.749	0.302	0.124	0.362	0	5.52
Fatty acid 24:1	g/100 g	0.003	0.001	0.002	0.005	0.005	0.004	0.008	0.001	0.001	0	0
Fatty acid 24:1 (/100 g TFA)	g/100 g TFA	0.067	0.008	0.057	0.372	0.444	0.182	0.085	0.057	0.181	0	0
Fatty acid 6:0	g/100 g	0.002	0.002	0.002	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001
Fatty acid 6:0 (/100 g TFA)	g/100 g TFA	0.04	0.009	0.036	0.097	0.089	0.031	0.048	0.048	0.09	1.75	0.986
Fatty acid 8:0	g/100 g	0.003	0.002	0.002	0.001	0.002	0.004	0.008	0.002	0.003	0	0
Fatty acid 8:0 (/100 g TFA)	g/100 g TFA	0.067	0.011	0.043	0.097	0.178	0.189	0.085	0.111	0.362	0	0
Fatty acid cis 16:1	g/100 g	0.082	0.786	0.119	0.021	0.011	0.025	1.04	0.542	0.198	0.005	0.002
Fatty acid cis 16:1 (/100 g TFA)	g/100 g TFA	2.02	4.34	2.83	1.47	1.02	1.17	11.2	32.5	28.5	8.77	1.38
Fatty acid cis 18:1	g/100 g	0.487	5.07	0.475	0.276	0.119	0.233	2.56	0.44	0.2	0.01	0.033
Fatty acid cis 18:1 (/100 g TFA)	g/100 g TFA	12	28	11.3	19.4	11.4	11	27.7	26.4	28.9	17.5	29.2
Fatty acid cis 18:1 omega-7	g/100 g	0.051	0.331	0.084	0.021	0.015	0.041	0.291	0.181	0.082	0.002	0.003

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acid cis 18:1 omega-7 (/100 g TFA)	g/100 g TFA	1.27	1.83	2	1.47	1.44	1.95	3.15	10.9	11.8	3.51	2.76
Fatty acid cis 18:1 omega-9	g/100 g	0.436	4.74	0.391	0.255	0.104	0.192	2.27	0.258	0.118	0.008	0.03
Fatty acid cis 18:1 omega-9 (/100 g TFA)	g/100 g TFA	10.8	26.2	9.28	18	9.94	9.06	24.6	15.5	17	14	26.4
Fatty acid cis 18:2	g/100 g	0.305	0.616	0.243	0.06	0.079	0.242	0.295	0.023	0.018	0	0.014
Fatty acid cis 18:2 (/100 g TFA)	g/100 g TFA	7.53	3.4	5.78	4.2	7.52	11.4	3.19	1.36	2.53	0	12.4
Fatty acid cis,cis 18:2 omega-6	g/100 g	0.305	0.616	0.243	0.06	0.079	0.242	0.295	0.023	0.018	0	0.014
Fatty acid cis,cis 18:2 omega-6 (/100 g TFA)	g/100 g TFA	7.53	3.4	5.78	4.2	7.52	11.4	3.19	1.36	2.53	0	12.4
Fatty acids, total	g/100 g	4.05	18.1	4.21	1.42	1.05	2.12	9.24	1.67	0.69	0.06	0.11
Fatty acids, total long chain polyunsaturated omega-3	g/100 g	0.14	0.16	0.5	0.13	0.14	0.2	0.04	0.01	0.01	0	0
Fatty acids, total long chain polyunsaturated omega-3 (/100 g TFA)	g/100 g TFA	3.51	0.91	11.8	9.02	12.9	9.38	0.45	0.83	1.9	0	3.55
Fatty acids, total monounsaturated	g/100 g	0.69	6.38	0.69	0.32	0.15	0.29	4.07	1.12	0.45	0.02	0.04
Fatty acids, total monounsaturated (/100 g TFA)	g/100 g TFA	16.9	35.3	16.4	22.8	14.1	13.6	44.1	67.3	64.7	29.8	30.6

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acids, total monounsaturated trans	g/100 g	0.09	0.36	0.07	0.01	0.01	0.02	0.17	0.01	0	0	0
Fatty acids, total monounsaturated trans (/100 g TFA)	g/100 g TFA	2.24	1.96	1.69	0.97	0.8	1	1.85	0.33	0.14	0	0
Fatty acids, total polyunsaturated	g/100 g	0.68	1.28	1.16	0.35	0.38	0.75	0.62	0.06	0.05	0	0.03
Fatty acids, total polyunsaturated (/100 g TFA)	g/100 g TFA	16.8	7.1	27.6	24.5	36.6	35.6	6.67	3.85	7.73	0	22.9
Fatty acids, total polyunsaturated omega-3	g/100 g	0.25	0.55	0.62	0.14	0.15	0.25	0.09	0.03	0.02	0	0.01
Fatty acids, total polyunsaturated omega-3 (/100 g TFA)	g/100 g TFA	6.04	3.05	14.8	10	14.3	11.8	0.94	1.48	2.44	0	6.11
Fatty acids, total polyunsaturated omega-6	g/100 g	0.44	0.73	0.54	0.21	0.23	0.5	0.53	0.04	0.04	0	0.02
Fatty acids, total polyunsaturated omega-6 (/100 g TFA)	g/100 g TFA	10.8	4.05	12.8	14.4	22.3	23.8	5.73	2.37	5.29	0	16.8
Fatty acids, total polyunsaturated trans	g/100 g	0	0	0	0	0	0	0.01	0	0	0	0
Fatty acids, total polyunsaturated trans (/100 g TFA)	g/100 g TFA	0	0	0	0	0	0	0.06	0	0	0	0
Fatty acids, total saturated	g/100 g	2.68	10.4	2.36	0.75	0.52	1.08	4.55	0.48	0.19	0.04	0.05

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fatty acids, total saturated (/100 g TFA)	g/100 g TFA	66.2	57.6	56	52.7	49.3	50.8	49.2	28.9	27.6	70.2	46.5
Fatty acids, total trans	g/100 g	0.09	0.36	0.07	0.01	0.01	0.02	0.18	0.01	0	0	0
Fatty acids, total trans (/100 g TFA)	g/100 g TFA	2.24	1.96	1.69	0.97	0.8	1	1.91	0.33	0.14	0	0
Fatty acid trans 18:1	g/100 g	0.091	0.355	0.071	0.014	0.008	0.021	0.171	0.005	0.001	0	0
Fatty acid trans 18:1 (/100 g TFA)	g/100 g TFA	2.24	1.96	1.69	0.97	0.799	0.997	1.85	0.328	0.136	0	0
Fatty acid trans 18:1 omega-7	g/100 g	0.082	0.292	0.056	0.01	0.006	0.017	0.128	0.003	0	0	0
Fatty acid trans 18:1 omega-7 (/100 g TFA)	g/100 g TFA	2.03	1.61	1.32	0.679	0.621	0.8	1.39	0.166	0	0	0
Fatty acid trans 18:1 omega-9	g/100 g	0.008	0.063	0.016	0.004	0.002	0.004	0.042	0.003	0.001	0	0
Fatty acid trans 18:1 omega-9 (/100 g TFA)	g/100 g TFA	0.209	0.347	0.372	0.291	0.178	0.197	0.459	0.163	0.136	0	0
Fatty acid trans 18:2	g/100 g	0	0	0	0	0	0	0.006	0	0	0	0
Fatty acid trans 18:2 (/100 g TFA)	g/100 g TFA	0	0	0	0	0	0	0.06	0	0	0	0
Fatty acid trans 18:2 omega-6	g/100 g	0	0	0	0	0	0	0.006	0	0	0	0
Fatty acid trans 18:2 omega-6 (/100 g TFA)	g/100 g TFA	0	0	0	0	0	0	0.06	0	0	0	0
Fibre, total dietary	g/100 g	0	0	0	0	0	0	0	0	0	0	0

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Fibre, water-insoluble	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Fibre, water-soluble	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Folate food, naturally occurring food folates	µg/100 g	0	0	480	8	6	51	20	9	8	21	4
Folate, total	µg/100 g	0	0	480	8	6	51	20	9	8	21	4
Folic acid	µg/100 g	0	0	0	0	0	0	0	0	0	0	0
Fructose	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Gamma-tocopherol	mg/100 g	0.01	0.01	0.05	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0
Glucose	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Glutamic acid	mg/100 g	2460	1900	2280	1900	2330	1740	9950	3210	3160	9180	1710
Glycine	mg/100 g	914	1030	1150	1580	1520	863	9370	4660	4350	14500	883
Histidine	mg/100 g	477	326	500	511	455	399	1380	282	294	636	1500
Hydroxyproline	mg/100 g	97	272	142	387	197	110	3560	3300	3090	10800	0
Iodide	µg/100 g	1.3	1.1	2.9	2.3	1.1	4.3	5.5	0.8	0.8	2.8	3.2
Iron	mg/100 g	5.7	2.1	9.7	14.3	32	9.1	8.3	0.66	0.79	4.2	61
Isoleucine	mg/100 g	712	536	788	506	696	609	3240	498	505	1300	159
Lactose	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Lactose (monosaccharide equivalents)	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Leucine	mg/100 g	1510	1070	1640	1450	1470	1280	3920	1130	1130	2710	2870
Lysine	mg/100 g	1390	1060	1360	1150	1250	1040	4680	1120	1010	3450	1900
Magnesium	mg/100 g	22	16	19	11	16	18	45	4	3	12	2

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Maltose	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Maltose (monosaccharide equivalents)	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Manganese	µg/100 g	23	14	290	17	18	100	90	5	5	38	4
Methionine	mg/100 g	443	328	421	266	404	334	1530	238	217	737	212
Monosaccharides, total	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Niacin equivalents from tryptophan	mg/100 g	4.5	2.6	5.4	4.1	4	4.1	10	0.56	0.85	0	6.9
Niacin equivalents, total	mg/100 g	9.1	6.1	15	8.6	8.5	13	15	1.1	1.4	0	8.3
Niacin, preformed	mg/100 g	4.6	3.5	9.9	4.5	4.5	8.5	4.9	0.54	0.57	0	1.4
Nitrogen, total	g/100 g	2.85	2.31	3.15	3.01	3.14	2.56	12.9	5.72	5.56	15.7	3.52
Pantothenic acid	mg/100 g	1.8	0.75	7.3	0.49	0.46	3.5	0.69	0.05	0.13	0	0.13
Phenylalanine	mg/100 g	774	550	939	774	761	677	2730	710	713	1760	1550
Phosphorus	mg/100 g	210	151	380	220	240	260	1000	39	38	9	22
Potassium	mg/100 g	310	230	340	260	380	270	330	48	47	8	187
Proline	mg/100 g	724	662	867	1000	984	682	5650	3890	3820	12600	797
Protein	g/100 g	17.8	14.5	19.7	18.8	19.6	16	80.4	35.8	34.8	87.3	22
Proximates, total	g/100 g	99.6	99.6	99.5	100	100	99.3	101	106	105	93.8	101
Retinol	µg/100 g	9	9	15500	5	5	57	9	4	0	0	9
Riboflavin	mg/100 g	0.8	0.32	3.2	0.51	0.24	2.1	0.98	0	0.03	0	
Selenium	µg/100 g	4.4	2.1	21	14	16	88	28	5	5	2	11
Serine	mg/100 g	699	558	801	703	697	659	2700	1020	1010	2920	891
Sodium	mg/100 g	91	98	57	153	83	185	200	131	186	95	210

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Starch, total	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Starch, total (monosaccharide equivalents)	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Sucrose	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Sucrose (monosaccharide equivalents)	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Sugar, added	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Sugar, free	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Sugars, total	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Sugars, total (monosaccharide equivalents)	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Taurine	mg/100 g	181	246	46	194	251	190	10	10	10	0	0
Thiamin	mg/100 g	0.45	0.099	0.27	0.08	0.1	0.45	0.078	0	0	0	0
Threonine	mg/100 g	838	610	863	731	755	701	3480	735	727	1890	1210
Total carbohydrate by difference	g/100 g	0.36	0.35	0.54	0	0	0.74	0	0	0	6.19	0
Total carbohydrates by summation	g/100 g	0	0	0	0	0	0	0	0	0	0	0
Tryptophan	mg/100 g	265	154	315	243	233	239	587	33	50	0	405
Tyrosine	mg/100 g	577	418	666	477	520	518	3370	301	316	454	564
Valine	mg/100 g	920	674	1090	1040	1140	850	3660	819	845	2050	1880
Vitamin A, RAE	µg/100 g	9	9	15500	5	5	57	9	4	0	0	9
Vitamin A, RE	µg/100 g	9	9	15500	5	5	57	9	4	0	0	9

FoodID Food Name	Unit	M10074 Heart	M10075 Tongue	M10076 Liver	M10077 Lung	M10078 Spleen	M10079 Kidney	M10081 Tail	M10083 Tendon	M10084 Sinew	M10085 Gelatine	M10086 Blood
Vitamin B12	µg/100 g	8.5	5.4	41	3	5.3	27	9.4	0.38	0.69	0.59	0.1
Vitamin B6	mg/100 g	0.43	0.17	0.6	0.047	0.074	0.37	0.06	0.026	0.013	0	0.019
Vitamin C	mg/100 g	0	0	11.7	0	0	0	0	0	0	1.25	0
Vitamin D	µg/100 g	0	0	0	0	0	0.38	0	0	8.5	0	0.6
Vitamin E, ATE	mg/100 g	0	0	0.01	0	0	0	0.16	0	0	0	0
Vitamin K	µg/100 g	3.9	4.2	4	0	0	0	5	0	0	0	0
≥Water	g/100 g	76.1	64.2	72.4	78.3	78	79.6	3.2	67.9	68.9	5.7	78.3
Zinc	mg/100 g	1.99	2.1	3.1	1.35	2.6	2.4	2.6	0.74	0.75	0.1	0.13

Abbreviations: ATE = alpha-tocopherol equivalents; FSANZ = Food Standards Australia New Zealand; RAE = retinol activity equivalents; RE = retinol equivalents; TFA = total fatty acids

Appendix 5: Selected Composition of Deer Offals Expressed as Percentage of Reference Intakes

Key components in deer offal and co-product samples expressed as per 100 g (or per 10 g for dried samples – tail & gelatine) and as a percentage of recommended daily intake (DI), recommended dietary intake (RDI) or Estimated Safe and Adequate Daily Dietary Intakes (ESADDI) using Food Standards Australia New Zealand labelling regulations:

- Proximate DIs as specified in Food Standards Australia New Zealand (FSANZ) Standard 1.2.8 [7].
- Vitamin and mineral daily requirements as specified in Schedule 1 of the Food Standards Code [6] and source/good source thresholds as specified in Schedule 4 [8].

Cells highlighted in green reach 'source of' claim threshold and those highlighted dark green 'good source of'.

Venison Blood

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	378	4
Proximates			
Protein	g	22	44
Fat	g	0.1	0
Fat, saturated	g	0.05	0
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	0	0
Folate, total	µg	4	2
Niacin	mg	8.3	83
Pantothenic acid	mg	0.13	3
Riboflavin	mg	0	0
Thiamin	mg	0	0
Vitamin A, retinol equivalents	µg	9	1
Vitamin B6	mg	0.02	1
Vitamin B12	µg	0	5
Vitamin C	mg	0	0
Vitamin D	µg	1	6
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	0	0
Minerals			
Calcium	mg	5	1
Copper	mg	0.06	2
Iodine	µg	3.2	2
Iron	mg	61	508
Magnesium	mg	2	1
Manganese	µg	4	0
Phosphorus	mg	22	2
Potassium	mg	187	9
Selenium	µg	11	16
Sodium	mg	210	9
Zinc	mg	0.13	1

Venison Gelatine, Dried

Component	Unit	Value/100 g	Value/10 g	%RDI/10 g
Energy, total metabolisable, FSANZ	kJ	1500	1560	17
Proximates				
Protein	g	87.3	8.7	17
Fat	g	0.3	0	0
Fat, saturated	g	0.04	0	0
Available carbohydrate, FSANZ	g	0	0	0
Sugar, total	g	0	0	0
Fibre, total dietary	g	0	0	0
Vitamins				
Biotin	µg	0	0	0
Folate, total	µg	21	2.1	1
Niacin	mg	0	0	0
Pantothenic acid	mg	0	0	0
Riboflavin	mg	0	0	0
Thiamin	mg	0	0	0
Vitamin A, retinol equivalents	µg	0	0	0
Vitamin B6	mg	0	0	0
Vitamin B12	µg	1	0	3
Vitamin C	mg	1	0	0
Vitamin D	µg	0	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0	0
Vitamin K	µg	0	0	0
Minerals				
Calcium	mg	115	12	1
Copper	mg	0.21	0.02	1
Iodine	µg	2.8	0.3	0
Iron	mg	4.2	0.4	4
Magnesium	mg	12	1	0
Manganese	µg	38	4	0
Phosphorus	mg	9	1	0
Potassium	mg	8	1	0
Selenium	µg	2	0	0
Sodium	mg	95	10	0
Zinc	mg	0.1	0	0

Venison Heart

Component	Unit	Value/100 g	%DI/RDI/ESADDI per 100 g
Energy, total metabolisable, FSANZ	kJ	474	5
Proximates			
Protein	g	17.8	36
Fat	g	4.6	7
Fat, saturated	g	2.68	11
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	3	10
Folate, total	µg	0	0
Niacin	mg	9.1	91
Pantothenic acid	mg	1.8	36
Riboflavin	mg	0.8	47
Thiamin	mg	0.45	41
Vitamin A, retinol equivalents	µg	9	1
Vitamin B6	mg	0.43	27
Vitamin B12	µg	8.5	425
Vitamin C	mg	0	0
Vitamin D	µg	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	4	5
Minerals			
Calcium	mg	5	1
Copper	mg	0.35	12
Iodine	µg	1.3	1
Iron	mg	5.7	48
Magnesium	mg	22	7
Manganese	µg	23	0
Phosphorus	mg	210	21
Potassium	mg	310	16
Selenium	µg	4.4	6
Sodium	mg	91	4
Zinc	mg	1.99	17

Venison Kidney

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	360	4
Proximates			
Protein	g	16	32
Fat	g	2.4	3
Fat, saturated	g	1.08	5
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	78	260
Folate, total	µg	51	26
Niacin	mg	13	130
Pantothenic acid	mg	3.5	70
Riboflavin	mg	2.1	124
Thiamin	mg	0.45	41
Vitamin A, retinol equivalents	µg	57	8
Vitamin B6	mg	0.37	23
Vitamin B12	µg	27	1350
Vitamin C	mg	0	0
Vitamin D	µg	0	4
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	0	0
Minerals			
Calcium	mg	7	1
Copper	mg	0.57	19
Iodine	µg	4.3	3
Iron	mg	9.1	76
Magnesium	mg	18	6
Manganese	µg	100	2
Phosphorus	mg	260	26
Potassium	mg	270	14
Selenium	µg	88	126
Sodium	mg	185	8
Zinc	mg	2.4	20

Venison Liver

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	512	6
Proximates			
Protein	g	19.7	39
Fat	g	4.8	7
Fat, saturated	g	2.36	10
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	110	367
Folate, total	µg	480	240
Niacin	mg	15	150
Pantothenic acid	mg	7.3	146
Riboflavin	mg	3.2	188
Thiamin	mg	0.27	25
Vitamin A, retinol equivalents	µg	15500	2067
Vitamin B6	mg	0.6	38
Vitamin B12	µg	41	2050
Vitamin C	mg	12	29
Vitamin D	µg	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	4	5
Minerals			
Calcium	mg	4	1
Copper	mg	0.48	16
Iodine	µg	2.9	2
Iron	mg	9.7	81
Magnesium	mg	19	6
Manganese	µg	290	6
Phosphorus	mg	380	38
Potassium	mg	340	17
Selenium	µg	21	30
Sodium	mg	57	2
Zinc	mg	3.1	26

Venison Lung

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	396	5
Proximates			
Protein	g	18.8	38
Fat	g	2.1	3
Fat, saturated	g	0.75	3
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	3	11
Folate, total	µg	8	4
Niacin	mg	8.6	86
Pantothenic acid	mg	0.49	10
Riboflavin	mg	0.51	30
Thiamin	mg	0.08	7
Vitamin A, retinol equivalents	µg	5	1
Vitamin B6	mg	0.05	3
Vitamin B12	µg	3	150
Vitamin C	mg	0	0
Vitamin D	µg	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	0	0
Minerals			
Calcium	mg	9	1
Copper	mg	0.42	14
Iodine	µg	2.3	2
Iron	mg	14.3	119
Magnesium	mg	11	3
Manganese	µg	17	0
Phosphorus	mg	220	22
Potassium	mg	260	13
Selenium	µg	14	20
Sodium	mg	153	7
Zinc	mg	1.35	11

Venison Sinew

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	630	7
Proximates			
Protein	g	34.8	70
Fat	g	1.1	2
Fat, saturated	g	0.19	1
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	0	0
Folate, total	µg	8	4
Niacin	mg	1.4	14
Pantothenic acid	mg	0.13	3
Riboflavin	mg	0.03	2
Thiamin	mg	0	0
Vitamin A, retinol equivalents	µg	0	0
Vitamin B6	mg	0.01	1
Vitamin B12	µg	1	35
Vitamin C	mg	0	0
Vitamin D	µg	9	85
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	0	0
Minerals			
Calcium	mg	14	2
Copper	mg	0.02	1
Iodine	µg	0.8	1
Iron	mg	0.79	7
Magnesium	mg	3	1
Manganese	µg	5	0
Phosphorus	mg	38	4
Potassium	mg	47	2
Selenium	µg	5	7
Sodium	mg	186	8
Zinc	mg	0.75	6

Venison Spleen

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	386	4
Proximates			
Protein	g	19.6	39
Fat	g	1.4	2
Fat, saturated	g	0.52	2
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	2	6
Folate, total	µg	6	3
Niacin	mg	8.5	85
Pantothenic acid	mg	0..46	9
Riboflavin	mg	0.24	14
Thiamin	mg	0.1	9
Vitamin A, retinol equivalents	µg	5	1
Vitamin B6	mg	0.07	5
Vitamin B12	µg	5	265
Vitamin C	mg	0	0
Vitamin D	µg	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	0	0
Minerals			
Calcium	mg	5	1
Copper	mg	0.08	3
Iodine	µg	1.1	1
Iron	mg	32	267
Magnesium	mg	16	5
Manganese	µg	18	0
Phosphorus	mg	240	24
Potassium	mg	380	19
Selenium	µg	16	23
Sodium	mg	83	4
Zinc	mg	2.6	22

Venison Tail, Dried

Component	Unit	Value/100 g	Value/10 g	%RDI/10 g
Energy, total metabolisable, FSANZ	kJ	1840	184	2
Proximates				
Protein	g	80.4	8.0	16
Fat	g	12.7	1.3	2
Fat, saturated	g	4.55	0.45	2
Available carbohydrate, FSANZ	g	0	0	0
Sugar, total	g	0	0	0
Fibre, total dietary	g	0	0	0
Vitamins				
Biotin	µg	9	1	3
Folate, total	µg	20	2	1
Niacin	mg	15	1.5	15
Pantothenic acid	mg	0.69	0.1	1
Riboflavin	mg	0.98	0.1	6
Thiamin	mg	0.08	0.01	1
Vitamin A, retinol equivalents	µg	9	1	0
Vitamin B6	mg	0.06	0.01	0
Vitamin B12	µg	9	1	47
Vitamin C	mg	0	0	0
Vitamin D	µg	0	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0.2	0	0
Vitamin K	µg	5	1	1
Minerals				
Calcium	mg	1500	150	19
Copper	mg	0.37	0.4	1
Iodine	µg	5.5	0.55	0
Iron	mg	8.3	0.83	7
Magnesium	mg	45	5	1
Manganese	µg	90	9	0
Phosphorus	mg	1000	100	10
Potassium	mg	330	33	2
Selenium	µg	28	2.8	4
Sodium	mg	200	20	1
Zinc	mg	2.6	0.26	2

Venison Tendon

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	673	8
Proximates			
Protein	g	35.8	72
Fat	g	1.8	3
Fat, saturated	g	0.48	2
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	0	0
Folate, total	µg	9	5
Niacin	mg	1.1	11
Pantothenic acid	mg	0.05	1
Riboflavin	mg	0	0
Thiamin	mg	0	0
Vitamin A, retinol equivalents	µg	4	1
Vitamin B6	mg	0.03	2
Vitamin B12	µg	0	19
Vitamin C	mg	0	0
Vitamin D	µg	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	0	0
Minerals			
Calcium	mg	8	1
Copper	mg	0.05	2
Iodine	µg	0.8	1
Iron	mg	0.66	6
Magnesium	mg	4	1
Manganese	µg	5	0
Phosphorus	mg	39	4
Potassium	mg	48	2
Selenium	µg	5	7
Sodium	mg	131	6
Zinc	mg	0.74	6

Venison Tongue

Component	Unit	Value/100 g	%RDI/100 g
Energy, total metabolisable, FSANZ	kJ	993	11
Proximates			
Protein	g	14.5	29
Fat	g	20.2	29
Fat, saturated	g	10.4	43
Available carbohydrate, FSANZ	g	0	0
Sugar, total	g	0	0
Fibre, total dietary	g	0	0
Vitamins			
Biotin	µg	0	0
Folate, total	µg	0	0
Niacin	mg	6.1	61
Pantothenic acid	mg	0.75	15
Riboflavin	mg	0.32	19
Thiamin	mg	0.1	9
Vitamin A, retinol equivalents	µg	9	1
Vitamin B6	mg	0.17	11
Vitamin B12	µg	5.4	270
Vitamin C	mg	0	0
Vitamin D	µg	0	0
Vitamin E, alpha-tocopherol equivalents	mg	0	0
Vitamin K	µg	4	5
Minerals			
Calcium	mg	5	1
Copper	mg	0.12	4
Iodine	µg	1.1	1
Iron	mg	2.1	18
Magnesium	mg	16	5
Manganese	µg	14	0
Phosphorus	mg	151	15
Potassium	mg	230	12
Selenium	µg	2.1	3
Sodium	mg	98	4
Zinc	mg	2.1	18

Appendix 6: Claims

Table 12: Pre-approved general level health claims for the nutrients present in deer offal and co-products as specified in Schedule 4 of the Food Standards Code [8].

Nutrient	Health effect	Map to generic health area
Protein	Helps build and repair body tissues	Cell & tissue growth
	Necessary for normal growth and development of bone in children (4 yr+)	Growth & development in children
	Contributes to the growth of muscle mass	Physical performance
	Contributes to the maintenance of muscle mass	Physical performance
	Contributes to the maintenance of normal bones	Bone health
	Necessary for normal growth and development in children (4 yr+)	Growth & development in children
Biotin	Contributes to normal fat metabolism and energy production	Energy & metabolism
	Contributes to normal functioning of the nervous system	Brain and nervous system
	Contributes to normal macronutrient metabolism	Energy & metabolism
	Contributes to normal psychological function	Brain and nervous system
	Contributes to maintenance of normal hair	Hair & nails
	Contributes to maintenance of normal skin and mucous membranes	Skin
	Hormone synthesis	Hormonal function
Folate	Necessary for normal blood formation	Heart & circulation
	Necessary for normal cell division	Cell & tissue growth
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to maternal tissue growth during pregnancy	Pregnancy
	Contributes to normal amino acid synthesis	Cell & tissue growth
	Contributes to normal homocysteine metabolism	Heart & circulation
	Contributes to normal psychological function	Brain and nervous system
	Contributes to normal immune system function	Immune function & inflammation
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Niacin (B3)	Necessary for normal neurological function	Brain and nervous system
	Necessary for normal energy release from food	Energy & metabolism
	Necessary for normal structure and function of skin and mucous membranes	Skin
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal psychological function	Brain and nervous system
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue

Pantothenic acid	Necessary for normal fat metabolism	Energy & metabolism
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal energy production	Energy & metabolism
	Contributes to normal mental performance	Brain and nervous system
	Contributes to normal synthesis and metabolism of steroid hormones, vitamin D and some neurotransmitters	Hormonal function
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Riboflavin (B2)	Contributes to normal iron transport and metabolism	Energy & metabolism
	Contributes to normal energy release from food	Energy & metabolism
	Contributes to normal skin and mucous membrane structure and function	Skin
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal functioning of the nervous system	Brain and nervous system
	Contributes to the maintenance of normal red blood cells	Heart & circulation
	Contributes to the maintenance of normal vision	Eye health
	Contributes to the protection of cells from oxidative stress	Prevention oxidative damage (antioxidant)
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Thiamin (B1)	Necessary for normal carbohydrate metabolism	Energy & metabolism
	Necessary for normal neurological and cardiac function	Brain and nervous system; Heart & circulation
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal energy production	Energy & metabolism
	Contributes to normal psychological function	Brain and nervous system
Vitamin A	Necessary for normal vision	Eye health
	Necessary for normal skin and mucous membrane structure and function	Skin
	Necessary for normal cell differentiation	Cell & tissue growth
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal iron metabolism	Energy & metabolism
	Contributes to normal immune system function	Immune function & inflammation
Vitamin B6	Necessary for normal protein metabolism	Energy & metabolism
	Necessary for normal iron transport and metabolism	Energy & metabolism
	Contributes to normal growth and development in children	Growth & development in children

	Contributes to normal cysteine synthesis	
	Contributes to normal energy metabolism	Energy & metabolism
	Contributes to normal functioning of the nervous system	Brain and nervous system
	Contributes to normal homocysteine metabolism	Heart & circulation
	Contributes to normal glycogen metabolism	Energy & metabolism
	Contributes to normal psychological function	Brain and nervous system
	Contributes to normal red blood cell formation	Heart & circulation
	Contributes to normal immune system function	Immune function & inflammation
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
	Contributes to the regulation of hormonal activity	Hormonal function
Vitamin B12	Necessary for normal cell division	Cell & tissue growth
	Contributes to normal blood formation	Heart & circulation
	Necessary for normal neurological structure and function	Brain and nervous system
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal energy metabolism	Energy & metabolism
	Contributes to normal homocysteine metabolism	Heart & circulation
	Contributes to normal psychological function	Brain and nervous system
	Contributes to normal immune system function	Immune function & inflammation
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Vitamin C	Contributes to iron absorption from food	Energy & metabolism
	Necessary for normal connective tissue structure and function	Joint health; Cell & tissue growth; Bone health
	Necessary for normal blood vessel structure and function	Heart & circulation
	Contributes to cell protection from free radical damage	Prevention oxidative damage (antioxidant)
	Necessary for normal neurological function	Brain and nervous system
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal collagen formation for the normal structure of cartilage	Joint health
	Contributes to normal collagen formation for the normal structure of bones	Bone health
	Contributes to normal collagen formation for the normal function of teeth	Oral health
	Contributes to normal collagen formation for the normal function of gums	Oral health
	Contributes to normal collagen formation for the normal function of skin	Skin

	Contributes to normal energy metabolism	Energy & metabolism
	Contributes to normal psychological function	Brain and nervous system
	Contributes to the normal immune system function	Immune function & inflammation
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Vitamin D	Necessary for normal absorption and utilisation of calcium and phosphorus	Bone health
	Contributes to normal cell division	Cell & tissue growth
	Necessary for normal bone structure	Bone health
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal blood calcium levels	
	Contributes to the maintenance of normal muscle function	Physical performance
	Contributes to the maintenance of normal teeth	Oral health
	Contributes to the normal function of the immune system	Immune function & inflammation
Calcium	Enhances bone mineral density	Bone health
	Reduces risk of osteoporosis in people over 65	Bone health
	Reduces risk of osteoporotic fracture in people over 65	Bone health
	Necessary for normal teeth and bone structure	Bone health; Oral health
	Necessary for normal nerve and muscle function	Brain and nervous system; Physical performance
	Necessary for normal blood coagulation	Heart & circulation
	Contributes to normal energy metabolism	Energy & metabolism
	Contributes to the normal function of digestive enzymes	Digestive health
	Contributes to normal cell division	Cell & tissue growth
	Contributes to normal growth and development in children	Growth & development in children
Copper	Contributes to normal connective tissue structure	Joint health; Cell & tissue growth; Bone health
	Contributes to normal iron transport and metabolism	Energy & metabolism
	Contributes to cell protection from free radical damage	Prevention oxidative damage (antioxidant)
	Necessary for normal energy production	Energy & metabolism
	Necessary for normal neurological function	Brain and nervous system
	Necessary for normal immune system function	Immune function & inflammation
	Necessary for normal skin and hair colouration	Skin; Hair & nails
	Contributes to normal growth and development in children	Growth & development in children
Iron	Necessary for normal oxygen transport	Heart & circulation

	Contributes to normal energy production	Energy & metabolism
	Necessary for normal immune system function	Immune function & inflammation
	Contributes to normal blood formation	Heart & circulation
	Necessary for normal neurological development in the foetus	Pregnancy
	Contributes to normal cognitive function	Brain and nervous system
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
	Necessary for normal cell division	Cell & tissue growth
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal cognitive development in children	Growth & development in children
Magnesium	Contributes to normal energy metabolism	Energy & metabolism
	Necessary for normal electrolyte balance	Hydration
	Necessary for normal nerve and muscle function	Brain and nervous system; Physical performance
	Necessary for teeth and bone structure	Bone health; Oral health
	Contributes to a reduction of tiredness and fatigue	Tiredness & fatigue
	Necessary for normal protein synthesis	
	Contributes to normal psychological function	Brain and nervous system
	Necessary for normal cell division	Cell & tissue growth
	Contributes to normal growth and development in children	Growth & development in children
Phosphorus	Necessary for normal teeth and bone structure	Bone health; Oral health+D6
	Necessary for the normal cell membrane structure	Cell & tissue growth
	Necessary for normal energy metabolism	Energy & metabolism
	Contributes to normal growth and development in children	Growth & development in children
Potassium	Necessary for normal water and electrolyte balance	Hydration
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal functioning of the nervous system	Brain and nervous system
	Contributes to normal muscle function	Physical performance
Selenium	Necessary for normal immune system function	Immune function & inflammation
	Necessary for the normal utilisation of iodine in the production of thyroid hormones	Hormonal function
	Necessary for cell protection from some types of free radical damage	Prevention oxidative damage (antioxidant)
	Contributes to normal sperm production	Reproductive health
	Contributes to the maintenance of normal hair and nails	Hair & nails

	Contributes to normal growth and development in children	Growth & development in children
Sodium	Diet low in salt or sodium reduces blood pressure	Heart & circulation
Zinc	Necessary for normal immune system function	Immune function & inflammation
	Necessary for normal cell division	Cell & tissue growth
	Contributes to normal skin structure and wound healing	Skin
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal acid-base metabolism	
	Contributes to normal carbohydrate metabolism	Energy & metabolism
	Contributes to normal cognitive function	Brain and nervous system
	Contributes to normal fertility and reproduction	Reproductive health
	Contributes to normal macronutrient metabolism	Energy & metabolism
	Contributes to normal metabolism of fatty acids	Energy & metabolism
	Contributes to normal metabolism of vitamin A	Energy & metabolism
	Contributes to normal protein synthesis	Cell & tissue growth
	Contributes to the maintenance of normal bones	Bone health
	Contributes to the maintenance of normal hair and nails	Hair & nails
	Contributes to the maintenance of normal testosterone levels in the blood	Reproductive health
	Contributes to cell protection from free radicals	Prevention oxidative damage (antioxidant)
	Contributes to the maintenance of normal vision	Eye health