UNDERSTANDING CONTAMINATION RISK ASSOCIATED WITH PROTEIN FORTIFIED FOODS

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ABBREVIATIONS

AAF – Adverse Analytical Finding

AIS – Australian Institute of Sport

ASD – Accredited Sports Dietitian

ATRG – Australian Register of Therapeutic Goods

FSANZ – Food Standards Australia New Zealand

FSC – Food Standards Code

FSP – Food Safety Program

FSSF – Formulated Supplementary Sports Food

GMP – Good Manufacturing Practicing

HACCP – Hazard Analysis and Critical Control Point system

HASTA – Human and Supplement Testing Australia

MNDP – Master of Nutrition and Dietetic Practice

NIN – National Institute Network

NSO – National Sporting Organisation

PFF – Protein Fortified Food

PIF – Product Information Form

SIA – Sport Integrity Australia (formerly ASADA)

SME – Small-Medium Enterprise

THC – Tetrahydrocannabinol

WADA – World Anti-doping Agency

GLOSSARY

Term	Definition
Allergen contamination	Refers to the incidence where food ingredients or their components contain certain 'allergenic' ingredients that are not declared on a product label and can cause severe allergic reactions. The most common ingredients that cause allergic reactions in Australia are: peanuts, tree nuts, milk, eggs, sesame seeds, fish, shellfish, soy, lupin and wheat.
Botanical (Herbal) ingredients	Raw ingredients of plant origin that are permitted in the Food Standards Code and meet the conditions for making a health claim (Standard 1.2.7) (e.g. ginseng, guarana, Maca root, Mushroom extracts, spirulina etc.).
Formulated supplementary sports food (FSSF)	A product that is specifically formulated to assist sports people in achieving specific nutritional or performance goals, as regulated by the Australia New Zealand Food Standards Code (Standard 2.9.4).
Fortified food	Any human food with nutrients (i.e. vitamins and minerals) added to modify the nutritional composition.
Functional food	Foods enriched with additional nutrients or components outside their typical nutrient composition for the purpose of enhancing the functional properties of the inherent nutrient profile of the food.
General content claim for protein	For an Australian food label to read "Protein" the product must meet the 'General claim conditions' of at least 5g of protein per serving, as regulated by the Australia New Zealand Food Standards Code.
Good source of protein	For an Australian food label to read "Good Source of Protein" the product must contain at least 10g of protein per serving, as regulated by the Australia New Zealand Food Standards Code.
Isolated protein ingredient	Refers to concentrated single or blended protein sources, of animal or plant origin, used in the manufacturing of fortified foods and protein supplements (see Supplementary Table 2).
Protein fortified food (PFF)	Any human food with one or more isolated protein ingredients listed on the product label that is manufactured within the general 'Chapter 2: Food standards', excluding foods produced under Standard 2.9.4 'Formulated supplementary sports foods'. The term 'Protein fortified food' has been used to describe the particular groups of foods it applies to for the purposes of this project, however it is not defined as such within the Food Standards Code.
Protein supplement	Formulated consumer ready dried powder, bar or shake, high protein Sports Food/Fluid with one or more isolated protein ingredients with/without the addition of other active ingredients (i.e. carbohydrate, fat, individual amino acids, creatine, caffeine, beta-alanine) and with non-functional ingredients (i.e. flavourings, sweeteners, thickeners), regulated by the Australia New Zealand Food Standards Code (Standard 2.9.4) as a Formulated Supplementary Sports Food. The term '**Protein Supplement**' is used within the current Australian Institute of Sport, Sports Supplement Framework, however it is not specifically defined within the Food Standards Code.
Third party testing agency	Independent sports drug testing laboratories that provide recognised certification of food and supplements to protect athletes against the use of World Anti-Doping Agency Code prohibited substances.

EXECUTIVE SUMMARY

Contamination of dietary supplements with World Anti-Doping Agency (WADA) Code prohibited substances has been known for nearly 20 years (Catlin et al 2000; Kamber et al 2001). National Government directives (i.e. Sport Integrity Australia), sport initiated supplement policies and commercial entities assessing supplements for contamination with prohibited substances assist athletes to mitigate contamination risk. Recently, foods fortified with isolated protein ingredients, hereafter referred to as protein fortified foods (PFF's) are now widely available. Consumer demand of PFF's are driven by adept marketing, leveraging research on the functional and multi-system benefits of dietary protein. Food manufacturers are developing PFF's with label claims using 'protein' as a prime focus on foods inherently low in protein.

PFF's contain added isolated protein ingredients similar to those used in sports and protein supplements. Typically, PFF's are regulated under the Australia New Zealand Food Standards Code (FSC). While the Code provides specific legislation on the manufacturing of 'Formulated Supplementary Sports Foods – Standard 2.9.4' which covers foods specifically formulated to assist sports people in achieving specific nutritional or performance goals, the provision around PFF's is not defined. Therefore, the contamination risk associated with PFF's regulated under FSANZ and the subsequent management of this risk is unclear.

The objective of this report is to explore, evaluate and understand the risk of PFF's manufactured within Australia and readily available to athletes. A review of the current legislation regarding PFF's and subsequent management by government, industry and sports was undertaken. To broaden the scope of the review and ensure it aligns with current practices within sport, athletes, sports dietitians and food manufacturers were engaged to understand current practices in managing contamination risk associated with PFF's. Bench audits, interviews, questionnaires and email responses were used to understand the current practices of organisations and industry in controlling contamination of food products from foreign sources. The primary investigation focus considered PFF's manufactured under the FSANZ code and did not explore the potential risk of contamination with added botanical ingredients or Internationally manufactured PFF's.

The above process highlighted a series of key findings that provided guidance for the primary recommendations of this report. These are:

- NSO supplement policies typically align with recommendations outlined by Sport Integrity Australia and the Australian Institute of Sport (AIS) Sport Supplement Framework. However, neither Sport Integrity Australia or the AIS address contamination risk of PFF's.

- The majority of National Sporting Organisations (NSO's) identified dietary supplements as a risk for contamination with WADA prohibited substances and recommended third party batch testing certification (i.e. Human and Supplement Testing Australia (HASTA) and Informed Sport) as an effective process of reducing risk. Only two NSO supplement policies included PFF's as a potential contamination risk with WADA prohibited substances.

- Sports dietitians working with NSO's regularly recommended the use of supplements especially protein supplements (i.e. powders, bars and liquid mixed macronutrient supplements) with the majority recommending third party batch tested supplements. However, less than half of the sports dietitians surveyed regularly recommended the use of PFF's and the majority were confused about the requirement for third party batch testing of such foods, especially foods containing novel plant-based proteins such as Hemp.

- Elite athletes appeared well educated on the use of third party batch tested supplements to reduce contamination risk with WADA prohibited substances. However, athletes weren't able to differentiate a protein supplement, a PFF and a food high in protein. Further, athletes didn't identify hemp protein supplements as a higher contamination risk with WADA prohibited substances compared to other dairy and traditional isolated protein ingredients. Athletes appeared confused regarding which protein containing products present risk and which products should be third party batch tested.

- Protein as a macronutrient and functional ingredient was identified by food manufacturers as a major driver of consumer purchasing behaviour. Food manufacturers were unaware that isolated protein ingredients added to foods were a potential contamination risk with WADA prohibited substances. Current quality control processes of isolated protein ingredients and manufactured whole foods is focused on allergen and biological contaminants.

- There is a large number of PFF's and foods that make a 'protein' claim available in supermarkets. The addition of one or several isolated protein ingredients within processed foods is widely used by food manufacturers to comply with Food Standards code (FSC) legislation associated with protein claims made on food labels.

- The manufacturing processes of isolated dairy protein ingredients (i.e. whey and casein protein, milk solids etc.) and plant-based proteins (i.e. soy) are carefully regulated to minimise biological and allergen contamination. These regulations and quality control processes appear suitable to avoid contamination with WADA prohibited substances with the inclusion of isolated protein ingredients to foods. Additionally, if maintained within a food manufacturing system, there is no additional risk of contamination with WADA prohibited substances with PFF's within Australia compared to other manufactured, fortified foods, which is considered extremely low.
- There is an array of PFF's (i.e. smoothies, protein balls, protein bars) available at cafes and food outlets. PFF's were commonly prepared onsite with 'isolated protein supplement' powders or procured pre-prepared with unidentified isolated protein ingredients. PFF's available at cafes and food outlets present a higher contamination risk with WADA prohibited substances, due to a lack of clarity of the source of isolated protein ingredients, alongside possible inclusion of novel herbal/botanical ingredients (e.g. hemp).
- The manufacturing of food grade hemp protein is similar to dairy and plant-based proteins and therefore risk of contamination with WADA prohibited substances is likely similar. However, the isolated protein ingredient source of hemp protein may contain traces of the WADA prohibited substance Tetrahydrocannabinol (THC) and other cannabinoids. This is inherent to the ingredient and not introduced via contamination during the manufacturing of the protein.
- Currently, third party batch testing certification companies (i.e. HASTA) routinely test protein supplements for WADA prohibited substances. Isolated protein ingredients (excluding hemp) regulated by FSANZ and GMP processes are considered 'very low risk' ingredients for cross contamination with WADA prohibited substances, however, they may change risk profile once they are used in more complex, multi-ingredient protein supplements manufactured under FSANZ Standard 2.9.4.
- The need for third party batch testing PFF's is likely complicated (due to the matrix of ingredients and form of various foods), excessive, and cost prohibitive for food manufacturers.

Key findings and recommendations

- PFF's that are commercially manufactured within Australia under FSANZ present no additional risk of containing WADA prohibited substances than other processed foods with mixed ingredients.
- PFF's store-prepared by cafes and food outlets that contain unidentified ingredients provide unknown risk. Further, some PFF's are difficult to differentiate from protein supplements. Athletes should undertake risk management strategies ahead of ingestion for these PFF's.
- Sport Integrity Australia and the Australian Institute of Sport (AIS) should include advice on the assessed risk of PFF's to athletes alongside current supplement use recommendations. National Sporting Organisation supplement policies should incorporate the AIS and Sport Integrity Australia position on PFF's.
- Hemp protein has a risk of containing traces of THC and other cannabinoids inherent to the raw plant source. Currently, there is insufficient scientific evidence regarding the contamination profile of hemp protein and as such hemp protein containing PFF's and supplements should be avoided by athletes.

Keywords: contamination, doping, elite athletes, risk, functional, sport

1. INTRODUCTION

The risk of contamination of sports nutrition supplements with World Anti-Doping Agency (WADA) Code prohibited substances has been well known for nearly 20 years (Catlin et al 2000; Kamber et al 2001; Cooper, 2018). Government sporting institutions (National Institute Network; NIN), National Sporting Organisations (NSO's) and commercial sporting franchises have developed supplement policies and procedures to assist athletes manage the risk associated with inadvertent doping through supplement use. Sport Integrity Australia (formerly ASADA) alongside the AIS have diligently educated athletes about the associated risks of consuming supplements and more recently informed athletes on strategies to mitigate this risk. It is now well established that for athletes to manage the risk of contamination they should use supplements, certified by independent, third party testing companies that batch test supplements for a broad range of WADA prohibited substances. However, the contamination risk associated with fortified and supplemented foods regulated under Food Standards Australia and New Zealand (FSANZ) and the subsequent management of this risk is less clear.

Currently the main avenue for contamination of supplements can be classified as: 1) purposeful, clearly identified (within the ingredients list) inclusion of WADA prohibited substances within a supplement; 2) purposeful, but subversive inclusion (not identified within the ingredient list) of a WADA prohibited substance within a supplement; 3) contamination of a raw ingredient with a WADA prohibited substance that is contained within a supplement; and 4) the contamination of a supplement with a WADA prohibited substance via residue cross-contamination, due to poor quality control processes in the mixing of raw ingredients or packaging of ingredients into an end product. As outlined these contamination risks typically occur once the raw ingredients have left their manufacturing facilities and occur within supplement production facilities.

While the risks associated with supplement use is well understood, little attention has been afforded to foods supplemented or fortified with raw ingredients. Foods that contain 'added protein', more specifically – protein fortified foods (PFF's) warrant special attention given the wide range of foods currently available for purchase from food companies, online retailers, start-ups, café's and food outlets. In many instances, commercially available foods are fortified with several different types of isolated protein ingredients of both animal and plant origin. The use of PFF's amongst athletes and the associated risks are poorly understood and deserve special consideration.

At present, NSO's within Australia are grappling with the possible risks associated with PFF's and how these are included within supplement policies and more pointedly food provision programs to athletes. Several NSO's have well developed supplement policies that manage supplement risk in a consistent and cohesive manner, however, policies and approaches differ significantly in managing the risk and safety of PFF's. This project explores and evaluates the risk profile associated with PFF's commonly consumed by Australian athletes. Examples of foods or categories of foods included in this project are:

- Formulated Supplementary Sports Foods regulated by Food Standard 2.9.4 (Australian New Zealand Food Standards Code, FSC, 2017)
- Foods with added protein (PFF's):
    - Foods with animal origin fortified protein ingredients (e.g. high protein food bar, protein fortified smoothie)
    - Foods with plant origin fortified protein ingredients (e.g. high protein cereal bar, fortified protein ball, dairy-free cheese)
    - Foods produced for or by food outlets (Cafés, Ready-meal businesses) with added protein (e.g. protein balls, gym smoothies, vegan protein cookie).

The findings will provide information regarding:

- The risk of PFF's containing WADA prohibited substances;
- The value or requirement for independent third party batch testing for WADA prohibited substances of isolated protein ingredients within the food supply chain or PFF's commercially available;
- Processes athletes, sports and sport government agencies should undertake when considering PFF's.
- Therefore, the primary aims of this project was to determine the contamination risk profile of PFF's and establish future recommendations for athletes, sports and sport government agencies.

Australia New Zealand Food Standards Code

Food Standards Australia New Zealand (FSANZ) is the statutory authority in the Australian Government Health portfolio. The FSANZ Food Standards Code (FSC) is the legislative instrument by which food manufacturers are governed and provides comprehensive coverage of all aspects of food and beverage production, safety and labelling. In Australia, compliance with the FSC for all foods is monitored through various authorities in the states and territories. The Australian Government Department of Agriculture, Water and the Environment are responsible for the inspection and sampling of imported foods.

In Australia, food and medicines are regulated through different legislated frameworks in-line with their intended use and the potential risks they pose to public health and safety. The Therapeutic Goods Administration (TGA), the regulating authority for medicines, has acknowledged the increasing number of sports supplements that are marketed as foods in Australia by recently conducting public consultation to clarify certain sports foods as therapeutic goods. Some sports supplements contain ingredients that are not appropriate for food (e.g. multi-ingredient pre-workout and thermogenic supplements). The TGA have also acknowledged the 2016 supplement survey (Life Science Company LGC, 2016) and the more recent study (Otago University, NZ) on the prevalence of supplements containing WADA prohibited substances not listed on the label (Cooper, 2018).

Formulated Supplementary Sports Foods

Traditionally PFF's were formulated and manufactured in accordance with "Special purpose foods" Standard 2.9.4 Formulated supplementary sports foods (FSSF). Standard 2.9.4 lists the maximum amount of specific amino acids and other nutritive substances (e.g. creatine, L-carnitine) that may be added to a FSSF, primarily for the benefit of enhancing or supporting the increased nutritional demands associated with exercise and sport. More recently, with the growing market trend for increased dietary protein, naturally lower protein foods (e.g. bread, cereals, popcorn) are being fortified with animal or plant derived protein sources. Under the FSC **Schedule 4** 'Nutrition, health and related claims', for the product label to contain specific nutrient claims about 'Protein' certain conditions should be met. Additionally, 'higher protein' products such as protein bars where isolated protein ingredients are the primary components are increasingly being manufactured under Standards other than 2.9.4.

Fortified foods contain added nutrients (i.e. vitamins and minerals) to modify the nutritional composition of the product. The FSC has very specific rules with regard to 'Nutrition and fortification', with mandatory fortification of all commercially available bread products with folic acid, iodine (i.e. use of iodised salt) and thiamine within Australia (FSANZ, n.d.). While 'Sports foods' are regulated under Standard 2.9.4. FSSF, there are no stipulations for foods manufactured within general purpose food standards that include isolated protein ingredients. However, considering the parallels with existing long-standing nutrient fortification, the risk profile of adding isolated protein ingredients to food, is comparable to the low risk profile of micro-nutrient fortification, and explains why we used the term 'protein fortified food'.

Contamination Risk Mitigation Processes within the Australian Food System

Australia is considered to have one of the safest food supplies in the world (FSANZ - A guide to Standard 3.2.1 food Safety Programs, 2007). The national food safety standards specify the requirements that food manufacturers must follow to provide safe food whilst reducing the incidence of food borne illness. To meet these requirements, it is compulsory for high-risk sectors such as food service within vulnerable populations, processing of raw oysters, catering to the general public and manufacturing of fermented meat to have a Food Safety Program (FSP) (Australia New Zealand Food Standards Code, 2011). Most licensed food businesses are required to have an FSP. An appropriate FSP systematically identifies, monitors, rectifies and reviews the potential hazards of the business operations. A 'hazard' is defined as a biological, chemical or physical agent in, or condition of, food that has the potential to cause an adverse health effect in humans. The requirement of businesses to have a FSP in place is controlled by the local authority in the relevant state or territory where the business is located (NSW Government Food Authority, n.d.). The Hazard Analysis and Critical Control Point (HACCP) system adopted by the joint WHO/FOA Codex Alimentarius Commission, is an internationally recognised system used to identify and manage risk within food production. The HACCP system is widely adopted in food manufacturing FSP's across Australia, while others use systems based off HACCP concepts. Therefore, according to legislation, businesses must have a FSP in place but are not necessarily required to comply with the HACCP accreditation program.

Use of the term "Contamination" within the FSANZ food safety standards refers to the introduction or occurrence of a contaminant in food. A contaminant is defined as "any biological or chemical agent, foreign matter, or other substances that may compromise food safety or suitability" (FSANZ, 2016). Under the code, food is considered not suitable for consumption if it contains any matter or substance that is foreign to the nature of the food. Furthermore, a food is not unsuitable merely because it contains any matter or substance that is permitted by the Australia New Zealand FSC. In other words, all foods must comply with the stipulated food standards to be legally sold in Australia.

2. MATERIALS AND METHODS

The authors undertook a multi-modal review of the current legislation and sport supplement risk processes undertaken by government, industry and sports. Additionally, athletes, sports dietitians and food manufacturers were engaged to understand current awareness of PFF's and likelihood of PFF's containing WADA prohibited substances.

2.1 Review of National Sport Organisation supplement policies and provisions around the use of protein fortified foods

National Sport Organisation (NSO) supplement policies were retrieved through relevant websites or nutrition professional networks. A total of 20 NSO policies were reviewed (see Table 1) with respect to provisions for PFF's. Policies were benchmarked on other areas of contamination risk including reference to the Australian Institute of Sport (AIS) supplement framework, advocacy of third party batch testing, identifying appropriate third party auditors and supplements to avoid due to their high risk profile.

2.2 Survey of National Sport Nutrition Leads regarding the relevant functional foods considered a risk to Australian athletes

National sport nutrition leads (Sport Dietitians) and Accredited Sports Dietitians engaging with elite athletes (n=82) were invited to complete an online questionnaire (Qualtrics LLC, Utah, USA). The questionnaire (see Appendix A) was developed by the research team to obtain nutrition professionals' insights and perspectives on the perceived contamination risks associated with PFF's. The questionnaire gathered demographic information, dietary supplement and PFF recommendation and provision processes, practitioner perception of contamination risk associated with PFF's, and knowledge of the inclusion of PFF's within supplement policies.

2.3 Athlete engagement survey

A mixed-methods survey was designed to investigate elite athletes' use of and perceived risk associated with protein supplements and PFF's (see Appendix B). The survey was comprised of two parts, part one a guided online questionnaire accessed through a QR code and completed on a mobile device (Qualtrics LLC, Utah, USA). Questions were designed to explore the respondent's ability to recognise PFF's, the perceived doping risk associated with PFF's, the perceived difference in risk associated with animal and plant isolated protein ingredients, and additional risk associated with novel isolated plant protein ingredients such as hemp. Part two incorporated a focus group discussion with athletes addressing beliefs, current use, concerns and perceived doping risk of PFF's, as well as their current use of protein supplements and supplement risk management processes. All athletes surveyed were involved in elite training programs and had access to or had been previously educated by Accredited Sport Dietitians.

2.4 Food manufacturer contamination risk audit

A bench audit of the current contamination risk processes food manufacturers are legally required to undertake within Australia was conducted (e.g. HACCP and Allergen contamination processes). To further understand opportunity for cross contamination with WADA prohibited substances to occur within food production systems, interviews were undertaken with Australian manufacturing companies that produce functional foods readily available and sourced through supermarket supply chains (see Appendix C).

2.5 Protein fortified foods audit

A supermarket and online direct to consumer audit of PFF's readily available for purchase, likely consumed by Australian athletes and possibly presenting contamination risk was conducted through frequent online searches and weekly visits to large supermarket chains over a six-month period by one of the researchers (K0B) (see Supplementary Table 1). PFF's were defined as any human food with one or more isolated protein ingredients listed on the product label that is manufactured within the general 'Chapter 2: Food standards', including foods produced under Standard 2.9.4 'Formulated supplementary sports foods'.

The term PFF was used for the purposes of this project to focus on a particular group of foods, however is not used within the FSC to describe a food. Products were included whether their label contained the word 'Protein' or not. The large number of manufactured foods containing conventional isolated protein ingredients such as 'milk solids' and 'skim milk powders' were excluded from this audit.

2.6 Independent sports drug testing laboratory interview

An interview was conducted with one of Australia's leading Independent Supplement Certification laboratories (Third party testing laboratory) to investigate the processes for testing and auditing of protein supplements and PFF's. Expert opinion was documented with regards to contamination risks associated with PFF's and other botanical containing functional foods.

2.7 Protein fortified foods Café Survey

To investigate the prevalence and processes around PFF's available in retail food outlets, a survey of Australian Cafés was undertaken by Master of Nutrition and Dietetic Practice (MNDP) students at Bond University (see Appendix D). This sample was considered a representative sample of PFF's available for purchase in retail food outlets due to the health focused food culture of the South East Queensland area. The aim of the survey was to determine:

- Whether isolated protein ingredients or protein supplements are added to menu items, and the type of protein supplements (animal or plant) used;
- Whether food outlets sourced pre-prepared PFF's from a supplier;
- Where food outlets sourced isolated protein ingredients or protein supplements (smaller retail or wholesale supplement suppliers); and
- The use of botanical ingredients (e.g. Maca Powder, Guarana or Spirulina) in PFF's.

3. FINDINGS

3.1 Review of National Sport Organisation supplement policies and provisions around the use of protein-fortified foods

Twenty NSO's were reviewed to determine provisions regarding supplement and PFF use (Figure 1). Five NSO's did not have a standalone Supplement Policy; addressing supplement use in a Sports Science and Sports Medicine (SSSM) Policy (n=2); Anti-doping Policy (n=1) or did not address supplement use (n=2). The stated review or update frequency for the standalone Supplement Policies were inconsistent and were either not specified (n=11) or from annual to three-yearly.

3.1.1 AIS Supplement Framework

The AIS Supplement Framework was referenced in fifteen NSO supplement or SSSM policies. Three NSO policies included some aspect of the framework as an appendix, without outlining the framework in the body of the policy. Of the policies reviewed, nine reported supplement provision and practice to be bound to the AIS framework whilst others were either "Endorsed but not bound" or "Adapted" for the sport-specific requirements. Four policies included or linked to the most current AIS Framework, with the remaining either not incorporating a list or active link, provided an expired link, or listed an outdated supplement classification system. Currently, the AIS Supplement Framework does not address the use or associated considerations of consuming PFF's.

3.1.2 Independent Third Party Batch Testing

Regarding the advocacy of independent third party batch testing, eleven NSO policies provided well-defined information on the requirement for and processes around supplement testing, with three policies providing unclear information, and five failing to mention the third party batch testing. Of the eleven policies that outlined third party batch testing, only six identified appropriate third party auditors, namely HASTA and Informed Sport. Three policies only mentioned Informed Sport as a reputable third party auditor.

The outlining classification and types of supplements required to be third party batch tested were inconsistent across the various policies. While several policies outlined that NSO provided supplements should be batch tested, others stipulated that all AIS categorised Group A (including sports foods) and B supplements be third party batch tested. Other policies did not require mandatory testing of sports foods and medical supplements that fall within AIS categorised Group A supplements. Three policies did not specify which supplements should be third party batch tested.

In addition to the AIS Framework Group D list of WADA prohibited substances, nine NSO policies specified that these supplements be avoided. Most commonly reported supplements to be avoided were pre-workout, weight loss, multi-ingredient, network marketed, herbal and immune supplements as well as hormone modulators. Several policies suggested the use of a supplements outside of the 'permitted list' which required approval through the Chief Medical Officer, where others discouraged use of internationally sourced supplements or "other than well-known and reputable sports drinks and energy bars". Five NSO policies did not specifically address the use of higher risk supplements.

3.1.3 Protein fortified Foods (PFF's)

A search of NSO Supplement and SSSM Policies regarding the use, provision and/or potential risks associated with PFF's found that two of the twenty policies acknowledged the increasing prevalence of isolated protein ingredients to whole or processed food items carrying an associated 'cross-contamination' risk. Both policies directed athletes to focus on a well-planned 'food first' dietary approach, whilst being aware of ingredients added to ready to consume foods at the point of purchase. One policy prompted athletes to be cognisant that health promoting and performance enhancing food labels do not reflect the risk of contamination, and if uncertain of a foods' eligibility, to consult the Accredited Sports Dietitian (ASD) for further clarification and approval.

3.2 Survey of National Sport Nutrition Leads regarding the relevant functional foods considered a risk to Australian athletes

Of the sports dietitians surveyed (n=42), a high proportion reported recommending protein powders and protein containing sports foods (98%) as well as other supplements including creatine, b-alanine and multi-ingredient supplements (88%). The majority of sports dietitians (79%) advised athletes to only use third party batch tested supplements by checking the ASADA (now Sport Integrity Australia) app and encouraged them to retain an independent register of their supplement use including batch number details.

A small proportion (40%) of sports dietitians recommended athletes use foods (cereal bars, breakfast cereals, dairy goods) fortified with either animal (whey, casein) or traditional plant (soy isolate, soy crisps) protein ingredients. There were no appreciable differences in sports dietitians recommending animal versus plant sourced PFF's, however a majority (79%) of respondents did not recommend the use of 'newer' plant PFF's with ingredients such as hemp, pea and brown rice.

Free text analysis of survey responses revealed there was significant confusion amongst sports dietitians regarding what supplements and PFF's require third party batch testing and their perceived safety for use. Sports dietitians felt inadequately educated on 'real' risk of contamination associated with PFF's. Sports Dietitians sought additional information regarding the likely contamination of PFF's and difference in risk associated with PFF's compared to other manufactured foods.

3.3 Athlete engagement survey

Twenty elite athletes (24 ± 5 years; 9 males, 11 female) across four sports (Sprint Kayak, Swimming, Triathlon and BMX) participated in the Athlete Engagement Survey. The Olympic sport cohorts interviewed were utilised for their convenience during a time where COVID-19 restrictions limited access to athletes. The most commonly reported PFFs consumed by athletes were – protein nut/cereal bars, higher protein cereals and dairy based drinks with added isolated protein ingredients. In general, athletes felt that foods with added protein offer a beneficial and convenient option in meeting daily protein requirements and are 'somewhat confident' in their perceived ability to identify PFF's. However, the majority of athletes were unable to correctly identify PFF's and relied heavily on the front label displaying 'Protein' to determine whether isolated protein ingredients had been added to the food. For example, the majority of athletes correctly identified that Chobani Greek Yoghurt was not a PFF, whereas nearly half incorrectly identified Danone YoPRO Yoghurt a PFF (see Figure. 1b). In both yoghurts the protein is concentrated within the food, without added isolated protein ingredients, however the YoPRO label states 'High in natural protein - 15g'. It's likely the inclusion of 'protein' on the label creates confusion amongst athletes leading to misinterpretation. This confusion was reiterated in a comparison of muesli bars with a protein content of over 5g per serving, with only 10% of athletes surveyed correctly identifying 'Uncle Toby's Oats Breakfast Bakes' (5.8g Protein) as a PFF, while 70% correctly identified 'Carman's Protein Muesli Bars' (10.2g Protein) as a PFF (see Figure. 1c).

Figure 1 Athlete engagement survey responses – Identifying protein supplemented foods.

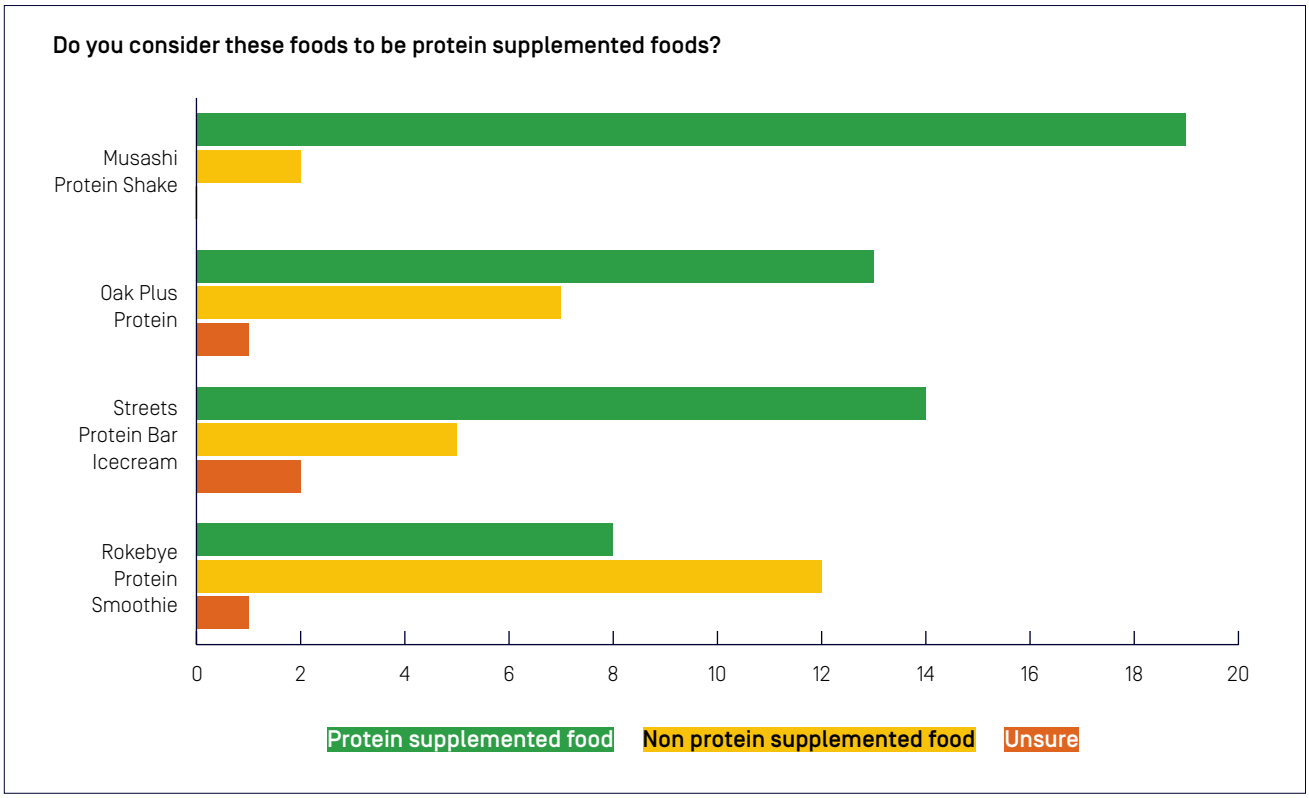

Figure 1A Milk products

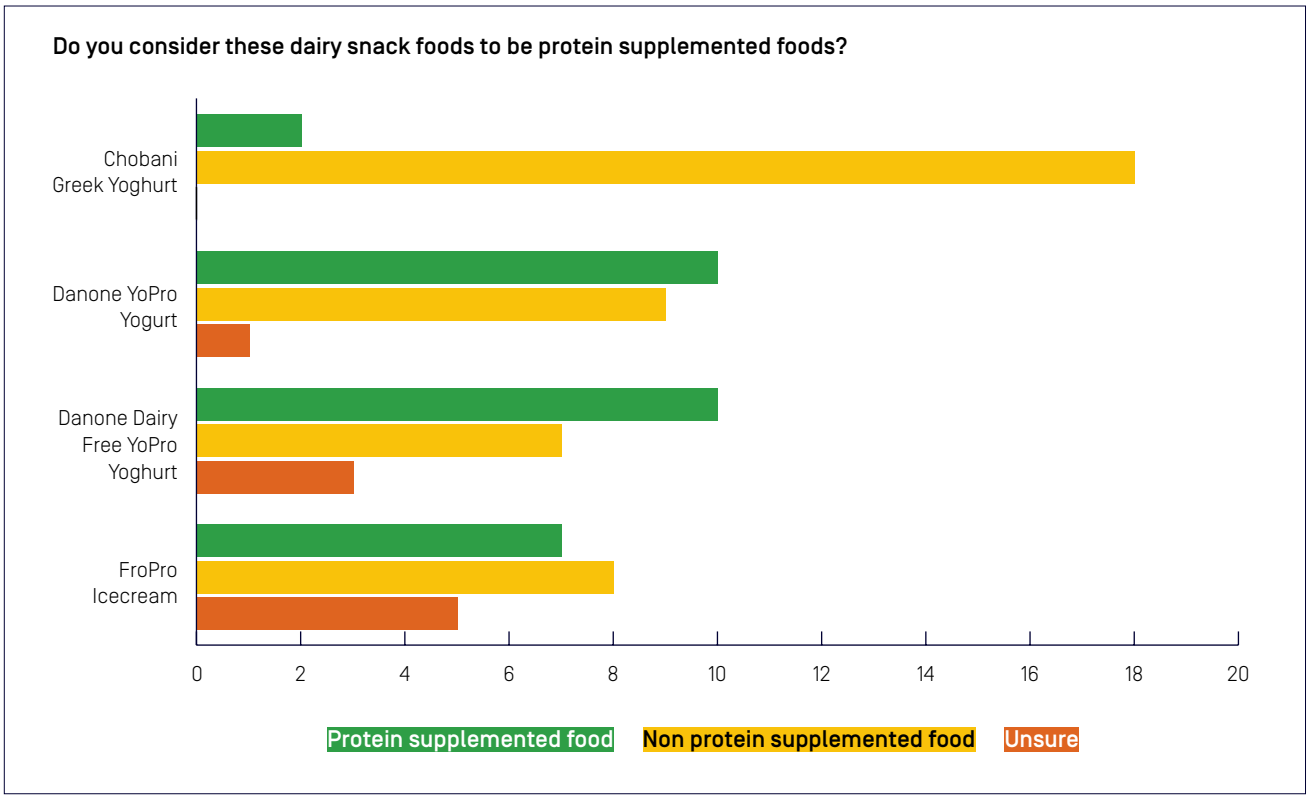

Figure 1B Dairy products

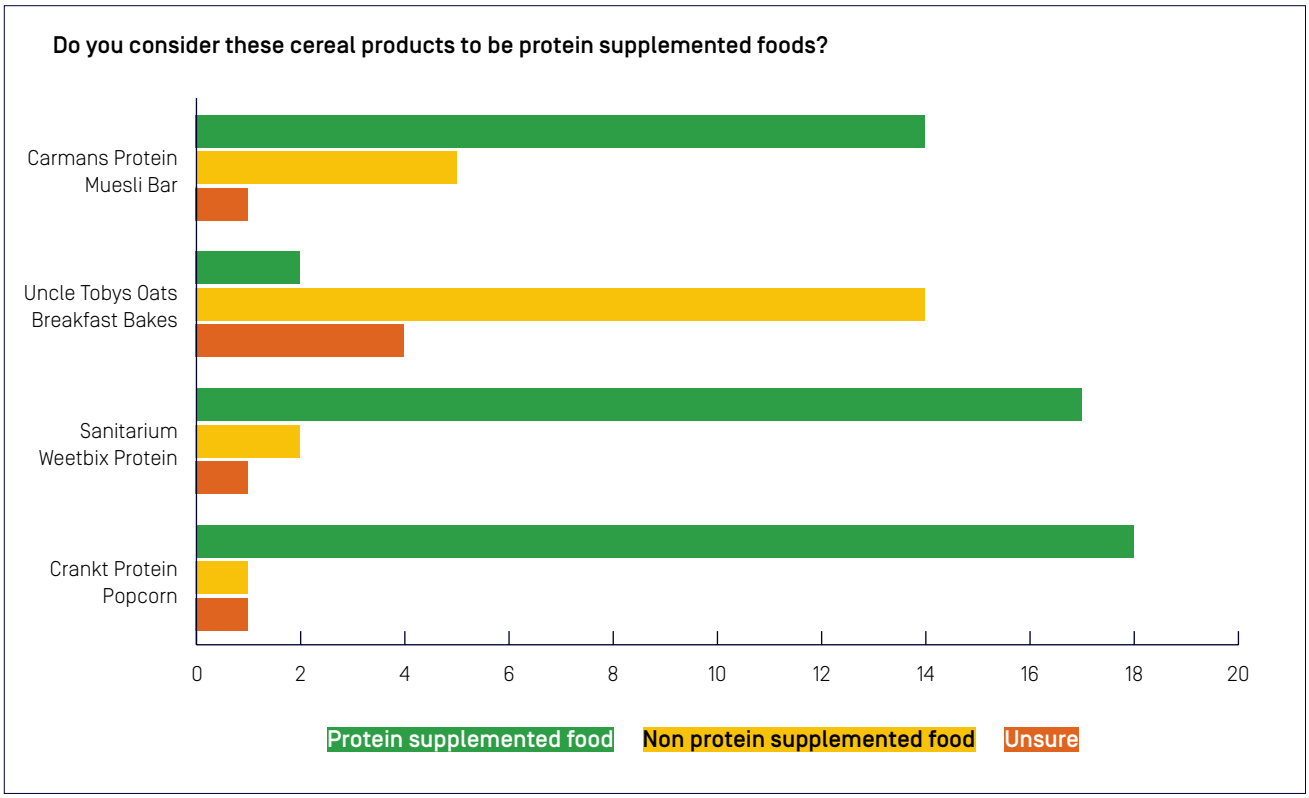

Figure 1C Cereal foods

Approximately 1 in 5 athletes intentionally check food labels or commercially available product descriptions to identify added protein within the ingredients list, highlighting that a small portion of athletes perceive a contamination risk associated with PFF's. The most common foods checked include commercially produced smoothies, protein balls as well as dairy drinks and muesli bars available from major supermarket outlets and independently owned convenience stores.

The majority of athletes surveyed (80%) reported that store-prepared PFF's supplemented with either animal (whey) or plant-based proteins (including hemp) have a moderate to high risk of contamination with WADA prohibited substances, while commercially manufactured packaged foods were considered lower risk. The "riskiest PFFs" reported were store-prepared PFF's from food outlets, small brand foods, PFFs targeting the bodybuilding market (e.g. protein bars) and products manufactured in the United States. Most athletes (75%) reported that there is 'no difference' or are 'unsure' of the risk profile between PFF's with added animal or plant proteins, while 45% felt that hemp protein provided additional risk compared to traditional plant protein sources such as soy.

The above findings suggest that athlete's knowledge on the correct interpretation of food labels in respect to PFF's is lacking and requires further education on best practice risk mitigation strategies with PFF's from Sport Integrity Australia, AIS, NSO's and sports dietitians.

As part of the survey, athletes were also questioned on their processes used to manage the risk of supplement contamination with WADA banned substances. All athletes had at some point received education on best practice risk mitigation strategies for supplement use. Nearly all athletes (95%) surveyed were using a protein supplement (powdered). While all (100%) athletes indicated they only used third party batch tested supplements, the Sport Integrity Australia app was used by 60%, with 15% preferring to talk the sports dietitians, 15% using Global DRO and 10% reporting a 'sometimes' use approach.

3.4 Food manufacturer contamination risk audit

The audit involved interviews with two large Australian commercial food manufacturers and expert opinion (via written response) from the Australian Food and Grocery Council (AFGC) and a major food manufacturer. Unfortunately, we were unable to interview three small-medium enterprises (SME's) that were contacted.

Manufacturers identified "Protein", as a macronutrient that was a key consumer driver, with the number of PFF's available likely to increase. None of the food manufacturers interviewed had encountered any issues relating to ingredients or formulated products containing WADA prohibited substances, however neither of the manufacturers actively tested for WADA prohibited substances with independent, third party batch testing. Such testing is not a requirement of Food Standards, as risk is considered low and cost to undertake testing prohibitive. For these reasons industry has not adopted the process of third party batch testing of commercially manufactured foods. One of the manufacturers did express interest in third party batch testing and was provided with relevant company details. To provide clarity regarding the risk profile of commercially manufactured foods, food manufacturers could test raw ingredients including isolated proteins as part of their research and development phase of product design.

Isolated protein ingredients are subject to the same level of control management as other product ingredients.
The isolated protein ingredients in question (dairy, soy and to some extent pea) are allergen containing. Allergen and biological contamination protocols are well established in food manufacturing and are applied to isolated protein ingredients.
Traditional isolated plant proteins and crisps (e.g. soy, pea) are produced by a small number of large international food ingredient manufacturers (e.g. Dupont Nutrition and Biosciences). Recently consumer demand for plant-based foods has driven the production and provision of newer isolated plant protein alternatives such as brown rice and hemp.

Due to the associated health risks (e.g. anaphylaxis) with manufactured foods containing or being contaminated with allergens, commercial manufacturers conduct routine secondary testing of product ingredients. No level of 'Allergen contamination' is considered acceptable for the shelf-life of a food and where there is any doubt, appropriate procedural systems such as precautionary labelling or a strict food recall must be followed to address allergen detection. For example, if soy was detected in a commercially manufactured food where it was not a declared allergen, the relevant food batch would either be withdrawn from sale and relabelled with a warning that the food may contain soy or alternatively the food may be recalled. Food recalls are coordinated nationally by FSANZ and also with the relevant State/Territory food authorities. Under Food Safety Standard 3.2.2 - 12, a food manufacturer, wholesaler or importer must have a system in place and comply with this system when recalling unsafe food (NSW Food Authority. n.d.). Food is recalled when it poses a possible public health and safety risk to consumers (e.g. Botulism contamination of dairy products). Food samples are stored by the manufacturer and undergo subsequent contamination testing for the entire shelf-life, as bacteria can develop after the food has been manufactured and available for sale. This process is considered a reactionary risk mitigation process, mitigating further health issues once contamination of a food has been identified. Although companies conduct their own allergen testing of random batches, there is a reliance on the ingredient supplier's compliance with various food safety programs, quality assurance accreditations (HACCP GFSI, ISO) and relevant product declarations (GMO free, pasture fed). The cost, quality, product specification and country of origin (COO) are all important considerations of an isolated protein ingredient for large food manufacturers with a dedicated ingredient research team. Although locally sourced ingredients are preferred, sometimes a consistent supply can only be assured through international supplier chains.

Third party testing of batches of isolated protein ingredients for WADA prohibited substances may be an option to understand contamination risk with commercially manufactured PFF's. However, as per the findings of this report, food manufacturing is highly regulated in Australia. Smaller manufacturers that are not fully audited and without appropriate QA processes in place may provide additional risk compared to larger companies, but this risk is still similar to other processed food products. Therefore, for companies that follow these regulation processes, are compliant with good manufacturing practices (GMP) and quality assurance (QA) processes, within Australia, the risk of contamination is low and the use of third party batch testing of isolated protein ingredients unnecessary.

3.5 Expert opinion - Independent Australian food council

Email correspondence with an Independent Australian food council suggested that local SMEs that manufacture (mix/blend) PFF's within Australia are highly likely to be purchasing the same isolated protein ingredients that larger companies purchase. These isolated protein ingredients will have Raw Material Specifications and/or Product Information Forms (PIF) associated with them which specify any contaminants. Cross-contamination with other ingredients containing WADA prohibited substances is also highly unlikely because these are not prevalent (like allergens are) in the food supply chain. Often SMEs are companies producing foods that make allergen free claims, so the level of attention to avoiding cross contamination is high. The Australian food council estimate the risk with imported foods to be much higher as visibility or understanding of practices in other manufacturing environments is poorly understood. However, in EU, US, Canada and Japan the GMP is likely similar and thus the risk of contamination is also low in PFF's.

3.6 Protein-fortified foods audit

Between June and December 2020, major supermarkets, independently owned stores, service stations and online businesses were audited for presence of PFF's by one of the researchers (KOB). The results of the audit are presented in Supplementary Table 1. The PFF details are tabulated in line with large supermarket categories and are indicative of prevalence rather than identifying every PFF available in store.

Of all PFF's audited (n = 30), only 2 PFF's (7%) (Uncle Toby's Breakfast bakes, Dairy-free Vegan cheese) did not make a "Protein" nutrient claim on the label. Breakfast foods, biscuits and snacks alongside health foods commonly contain PFF's. Most PFF's are fortified with 1-2 different isolated protein ingredients, however higher protein containing 'Protein bars' can contain up to seven protein sources through the use of protein blends and nuggets. Typically, higher protein snack foods that contain more than 10g of protein per serve use several different isolated dairy and soy protein ingredients. Approximately 3 in 4 (76%) foods listed in Supplementary Table 1 are manufactured in Australia/New Zealand under the FSANZ FSC, while the remainder are manufactured overseas (USA, UK, Scotland, Spain, Netherlands).

Isolated plant protein ingredients such as soy are most commonly used in PFF's. However, approximately 1 in 4 PFF's contained both animal and plant isolated protein ingredients. More recently, novel plant proteins (pea, wheat, lupin, almond) are being used to fortify the protein content in cereal-based breakfast foods and bakery goods (i.e. Protein bread mixes). Dairy alternative options (e.g. Dairy Free yoghurts, Vegan cheese) primarily use isolated soy protein ingredients. Isolated protein ingredients are commonly used to increase the protein content of foods inherently low in protein, targeted at 'protein-centric' consumers and 'allergen sensitive consumers' (i.e. GF). Many of these food items are expensive and have short product life cycles.

3.7 Independent sports drug testing laboratory interview

The Independent sports drug testing laboratory or 'third party testing agency' reported that dairy based protein supplements are most commonly submitted for testing, however, an increase in plant protein supplements was noted. Dairy-based protein supplements usually have fewer ingredients and are therefore easier to obtain a definitive result compared with multi-ingredient protein blends and powders. Isolated dairy protein ingredients are predominantly produced in Australia and New Zealand and adhere to strict food manufacturing and control regulations. As such, isolated dairy proteins are considered low-risk ingredients. Some larger companies have tested isolated dairy protein ingredients with no contamination issues reported to-date. Food safety program auditing is significantly greater in the dairy industry. Considering these factors, it's not surprising that no reported adverse/positive findings from dairy protein supplements and isolated protein ingredients were reported by the third party testing agency.

Plant proteins are typically a blend (e.g. pea and soy) of several isolated plant protein ingredients and other items to improve product texture and mouthfeel, which may increase contamination risk with WADA prohibited substances. The broader the range of ingredients and sources, the greater the risk of cross contamination within the product. Isolated plant proteins vary in quality and are sourced from overseas with potentially lower quality controls and inferior manufacturing processes. Contamination risk would be higher with a commercially available PFF's (e.g. Hemp protein ball) containing multiple plant protein sources compared to that of commercially produced products such as a PFF nut bar. Australian manufactured PFF nut bars typically contain between one and three different isolated plant protein ingredients – soy crisps, pea crisps and soy protein as a blend, however it would be expected their ingredients are sourced through food-grade, highly regulated, GMP audited manufacturers.

The third party testing agency at the time of interview did not test hemp products due to the high likelihood of them containing detectable levels of THC and other cannabinoids. They recommend athletes against the use of any hemp containing foods due to the varying levels of THC permitted in hemp food products under Standard 1.4.4. However, this contrasts with that of public perception with marketing of "natural", "raw" ingredients as safe due to non-adulteration.

The third party testing agency reported that they undertook minimal testing of PFF foods, other than protein bars; with the majority of food products tested being either Formulated Supplementary Sports Foods or electrolytes (drinks code). Approximately 2% of all supplements (bar, capsule, gel, liquid, powder, tablet) tested have resulted in positive detection of WADA prohibited substances. According to the third party testing agency, supplements marketed toward physique manipulation targeting increasing muscle mass or fat loss, remain the primary source of AAF.

If a sport undertakes sponsorship agreements with a food manufacturer they should audit their manufacturing processes and controls, ensuring quality materials, manufacturing processes and sourcing of ingredients is of the highest standard before formal arrangements are finalised.

3.7.1 Protein supplements – Dairy based

The third party testing agency reported that the majority of protein supplements tested are dairy based (predominantly Whey Protein Concentrate (WPC) & Whey Protein Isolate (WPI) formulations) with the majority of dairy proteins sourced from Australia or New Zealand. Australia and New Zealand are both significant global exporters of milk products. Powdered milk production is highly regulated, due to the significant food safety risks associated with intended populations of use (e.g. use in the manufacturing of infant formula). The FSANZ Food Standard Code contains the standards for production, processing, manufacturing and microbiological limits for all **dairy products**. Each state and territory in Australia have their own Dairy Industry regulator to ensure compliance with the code. For instance, in NSW, dairy is part of NSW Food Authority, and in Victoria the regulator is **Dairy Food Safety** .

3.7.2 Protein supplements – Vegetarian/Vegan

There are an increasing number of non-dairy protein powders in the Sport Supplement market; the third party testing agency receives predominantly soy, pea and rice protein supplements for testing. Soy, wheat, and pea are the most common sources used in the production of blended plant-based proteins globally and are produced primarily in countries such as Brazil, USA, Canada, China, and India. Like dairy, these proteins can be processed to different levels, from textured protein, to concentrates, to isolates. Quality can vary significantly, as a number of these isolated protein ingredients are processed for livestock feed as well as human consumption, and there are GMO versus non-GMO sources. Premium versions of these proteins for human consumption are commonly organic, non-GMO, and refined to isolates. All ingredients used in the manufacture of Formulated Supplementary Sports Foods must meet the food safety requirements of the FSC.

Hemp protein isolate is also now permitted for sale as a food in Australia and is being added to some Sport Supplement formulations. Hemp proteins are at high risk of containing traces of THC and other cannabinoids due to the hemp plant origin. The third party testing agency advised that although there were permitted levels for THC under the food standards code, there is no threshold for a permitted level of THC or other cannabinoids from WADA, and that WADA advises athletes that "Products, including foods and drinks, containing cannabinoids, are also prohibited." To date, no third party testing company appears to certify hemp containing supplements to our knowledge.

Based on the testing that the third party testing agency has performed, dairy based protein supplements offer low risk of contamination with WADA prohibited substances compared with other powdered supplements, such as pre-workouts and weight loss (thermogenic) supplements. Their observations reinforce that risks associated with isolated protein ingredients are low and only escalate once other 'active' ingredients are added within the supplement manufacturing process. This also highlights the importance of independent third party batch testing for supplements. The addition of isolated protein ingredients, particularly dairy protein, to commercially manufactured PFF's presents no additional risk of containing prohibited substances to other food ingredients.

3.8 Protein-fortified Food Café Survey

A total of 61 Cafés located in a metropolitan city on the east coast of Australia were approached to complete the survey with 57 outlets agreeing to participate.

- Forty-three percent of Cafés used protein powders in menu food/fluid items such as protein smoothies, truffles, balls, juices, acai bowls, vegan cookies and chocolate brownies.
- Nearly 3 in 5 (59%) Cafés reported selling PFF's purchasing these foods from another foodservice supplier.

Café Protein Suppliers	% (n)
Wholesale/foodservice distributor	44 (12)
Supermarkets	26 (7)
Online through a supplement retail store	11.5 (3)
Online from a wholesale supplement store	11.5 (3)
In bulk from a large commercial distributor	0
Unsure of supplier	7 (2)

Table 2 Protein Supplemented Food Survey results – Suppliers

While 44% of Cafés reported sourcing protein powders through a wholesale foodservice distributor, none were able to name the company. A local Food Services company was contacted to confirm whether or not they supply protein powders or crisps. The Food Service company is Australia's largest privately owned food service network, supplying many Cafés in the local metropolitan area. The only protein product in their inventory was a blended multi-ingredient protein powder which was not independently third party batch tested. One Café reported using 'Hemp protein' as a food ingredient. And finally, 7% of Cafés surveyed reported adding other functional ingredients or supplements to food/fluid menu items – including charcoal powder, spirulina, LSA, creatine and acetyl L-Carnitine.

4. DISCUSSION

The main finding of this report is that isolated protein ingredients added to fortify the protein content of processed foods, thereafter referred to as a 'protein fortified food' (PFF) present a low risk of contamination with WADA prohibited substances. The risk of contamination of isolated protein ingredients and/or PFF's, if maintained within the food manufacturing system appears no different to other food ingredients or manufactured foods. As such, athletes should be suitably informed that PFF's commercially manufactured within Australia under FSANZ regulation offer no additional risk than other processed foods. Isolated hemp protein presents a high risk of containing a naturally occurring WADA prohibited substance (THC) inherent to the source ingredient, but otherwise provides a similar low risk of contamination with additional WADA prohibited substances as other food ingredients. No level of contamination control can reduce this risk and unless certified free of THC, is a high-risk ingredient for returning a positive Adverse Analytical Finding (AAF).

Athletes frequently report using protein supplements in addition to traditional protein foods to enhance athletic performance, assist recovery and support general health and well-being. More recently there has been an increase in the availability of PFF's in major retailers as well as smaller food outlets including cafes. To-date, the risk of contamination with WADA prohibited substances of isolated protein ingredients that are used for food manufacturing or PFF's has not been well articulated. This report provides insight into the current level of understanding among athletes, administrators, sport nutrition professionals and food manufacturers regarding contamination risk of isolated protein ingredients and PFF's. Additionally, this report provides an overview of the possible risks associated with isolated protein ingredients used within food manufacturing processes alongside PFF's.

Currently, food manufacturers, government sport regulators, sports and athletes appear confused regarding the associated contamination risks of PFF's. We made several unsuccessful attempts to connect with SME's and larger well-known retailers for project involvement, but were met with confusion and indifference to the relevance of this project. The food industry manages isolated protein ingredients within processed foods (PFF's) similar to other food ingredients. Australian food manufacturers operate within local FSC regulations and are not required to undertake detection processes for WADA prohibited substances. Due to the scale of food manufacturing, alongside food manufacturing processes that regulate risk of allergen contamination, third party batch testing processes recommended by Sport Integrity Australia and independent sports supplement testing laboratories are cost prohibitive and appear unnecessary for PFF's.

Findings from this report suggest that food retailers are unaware of athlete and sport administrator concerns regarding the 'perceived' risk of PFF's containing WADA prohibited substances. Sport Integrity Australia and other NGO's are well placed to engage the food industry to educate SME, large manufacturers and ingredient suppliers that well defined and transparent GMP and contamination control process provide a safeguard to athletes regarding the 'perceived' risk of PFF's. Australian athletes value 'higher protein' foods, but are confused on differentiating a protein supplement from a high protein food and a PFF, particularly for dairy containing foods. Athlete's predominantly use label nutrient claims to recognise PFF's, while ~1 in 5 athletes read food ingredient lists. The fact that foods only require 5g of protein per serve to be able to make a general nutrient claim for 'protein' further complicates the issue (see Appendix E). Considering higher 'protein' containing foods are a leading market trend in the food industry, manufacturers are pursuing research and development of food formulas to enable more product label claims for protein. Only 1 in 2 athletes considered hemp protein to provide additional risk compared to traditional plant protein sources such as soy when added to PFF's. Education is required by Sport Integrity Australia and the AIS regarding the potential for THC concentrations, inherent in the hemp plant to be found in refined hemp protein foods and supplements.

The majority of sports nutrition practitioners surveyed for this report appeared unsure and subsequently concerned regarding the likely risk of PFF's containing WADA prohibited substances (Appendix F). A high proportion of practitioners recommended the use of third party batch tested protein supplements and protein-containing sports foods such as mixed macronutrient bars (high protein, high energy bar). Interestingly, only 2 in 5 practitioners encouraged the use of PFF's, which likely reflects their uncertainty regarding the relative risk of PFF's. This concern was further heightened by the addition of botanical compounds (e.g. spirulina, Maca). The findings of this report provide useful information for sports dietitians on the 'perceived' risks associated with PFF's.

Athletes are routinely educated on the contamination risks of WADA prohibited substances associated with supplements, sports foods and fluids. GSO, NSO, Sport Integrity Australia, the Australian Institute of Sport (AIS) alongside sports nutrition professionals have developed supplement frameworks, policies and procedures that educate and assist athletes mitigate this risk. Although food provision has been more heavily embedded within sport nutrition strategies to support athletes, little attention has been given to how PFF's should be incorporated into sport supplement policies. Our results suggest that NSO's have failed to acknowledge the growing trend of PFF's within their existing anti-doping or sport supplement policies.

The review of NSO supplement policies highlighted the significant variations between organisations with 90% of policies making no mention of PFF provision or the 'perceived' risks associated with their use. This report suggests that PFF's present no additional risk of containing WADA prohibited substances to other manufactured foods. PFF's are a high protein food source that can be safely recommended as a practical dietary protein food source to meet specific athlete individual nutrition requirements to support training and recovery.

Interviews with reputable Australian food manufacturers suggest the control processes involved with raw ingredients, particularly declared allergens such as dairy, soy and nuts are tightly regulated and managed. For instance, the Australian dairy industry is bound by the National Dairy Food Safety Regulatory Framework which involves federal and state regulatory agencies, dairy companies and Dairy Australia. The Regulatory Framework provides industry quality assurance programs across all sectors of the supply chain to take responsibility for food safety with potential risks continually monitored. The FSC has a specific standard (Standard 4.2.4 Primary production and processing standard for dairy products) relating to the use of dairy products. Fonterra Co-operative Group Limited (Fonterra) is one of the World's largest producers of isolated dairy proteins and their Certificate of Analysis (COA) data sheets specify microbial threshold and detection results for Aerobic plate, Coliforms (E.coli), Staphylococci, Yeast and mould, Salmonella, Listeria as well as meeting various compliance standards (Codex, FDA, EPA, NZFSA, EU) for lead, heavy metals, pesticides, phosphatase. Food standards associated with quality and contamination control appear adequate to control for and mitigate opportunity for contamination with WADA prohibited substances. As such foods with added isolated protein ingredients (PFF's) offer similar risk of containing WADA prohibited substances to other manufactured foods.

PFF's (i.e. a smoothie with added protein or protein ball) available through food outlets (i.e. cafes) are managed inconsistently by retailers and thus provide unknown risk for contamination with WADA prohibited substances. The Protein Fortified Food Café Survey undertaken in this project found that PFF's available at cafes were either 'store-prepared' with added isolated protein ingredients or protein supplements; or 'shelf-ready' PFF's purchased from local suppliers or large retail wholesalers. Further, some food outlets reported adding other ingredients such as botanicals (i.e. spirulina and Maca powder) to PFF's. While food outlets are required to operate within the FSC, our findings suggest that it's difficult to understand the risk profile of PFF's available at food outlets. Although the positive detection rates of Australian blended 'protein powders' is very low, with no adverse/positive findings from dairy protein powders reported (HASTA, 2020), it's difficult for an athlete to determine at the point of purchase the source of protein used and the addition of other ingredients in PFF's available at food outlets. Thus, the risks associated with PFF's at food outlets appear similar to that of protein supplements and should be treated with risk management strategies that align with supplements. In the case where an athlete has consumed a PFF purchased from a cafe before realising, they should ask staff to sight the protein used and/or the shelf-ready PFF and record the product details, batch numbers, with photographic evidence.

In conclusion, due to the high level of food regulation and allergen contamination control processes within Australia, athletes should have confidence that contamination with WADA prohibited substances within the food manufacturing industry is likely low and hence commercially manufactured, packaged PFF's provide no additional risk to other processed fortified foods athletes typically consume.

5. ATHLETE AND SPORT RECOMMENDATIONS

On the basis of our findings:

- Athletes can consume PFF's manufactured within Australia under FSANZ to enhance the timing of foods with increased protein content to optimise training outcomes and support health and well-being.
- There is no requirement for third party batch testing of PFF's, however, if athletes and practitioners are unable to differentiate a PFF from a protein supplement or unable to clearly identify the ingredients (i.e. in the case of a store-prepared PFF), risk management strategies that align with supplements should be implemented.
- Sport Integrity Australia and the AIS should provide recommendations regarding the suitability for consumption of PFF's commonly consumed by Australian athletes. These recommendations should be incorporated by NSO's into sport supplement policies to provide education to athletes, coaches and practitioners.

PROJECT LIMITATIONS

In conducting this project, there were several limitations that should be considered. Due to lack of knowledge and understanding of the issue, commercial food manufacturers were largely reluctant to engage when approached. Thus, the scale of food companies engaged was limited to large, established manufacturers. Further, it is assumed that 'all' food manufacturers comply with current FSANZ standards, however larger food manufacturers likely have more developed procedures and available resources to meet compliance requirements.

Athletes surveyed and interviewed in this project were part of elite training programs and had regular access to accredited sports dietitians in Olympic sports. This exposure likely influenced their level of knowledge and reported practices and should not be extrapolated to sub elite, developing and recreational athlete populations, nor to populations where athletes are engaging with inappropriately credentialed sports nutrition professionals.

This report has focussed solely on the addition of isolated protein ingredients within the Australian food industry and did not investigate the contamination risks for WADA prohibited substances associated with added botanical ingredients, which are increasingly being included in functional foods and therefore deserves further attention. While risk considerations are likely similar for PFF's manufactured internationally, this investigation was limited to Australian food controls and regulations.

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APPENDICES

Appendix A: Survey of National Sport Nutrition Leads regarding the relevant functional foods considered a risk to Australian athletes

1. What level of service provision do you provide to sports?
    a) Fee for service to athletes outside of NIN, sporting organisation agreement in private practice
    b) Engaged by NIN to deliver nutrition services to categorised athletes
    c) Engaged by sport organisation to deliver nutrition services to sport engaged athletes
    d) Engaged by sport to oversee national nutrition services in a nutrition lead position
    e) Other: please outline:

2. Do you recommend the use of protein powders, protein containing sports foods such as protein bars, Sustagen sport or other dietary supplement forms of protein?
    a) Yes
    b) No

3. If yes do you provide information or advice around WADA banned substance contamination risk and management?
    a) When recommending protein containing supplements, I think the risk is low and don't recommend any process
    b) When recommending protein containing supplements, I provide advice that there is risk and to manage that risk use major brands or whole foods
    c) When recommending brands, I only recommend those that I have researched and have knowledge of their contamination risk processes
    d) When recommending protein containing supplements, I advise the athlete to only use 3rd party audited products
    e) When recommending protein containing supplements, I advise the athlete to only use 3rd party audited products and check with the ASADA app
    f) When recommending protein containing supplements, I advise the athlete to only use 3rd party audited products by checking the ASADA app and encourage them to keep an independent register of their use including batch number (or keep this record myself on behalf of the athlete and sport)

4. Do you recommend the use of other supplements (pre-work outs, creatine, b-alanine, multi-ingredient supplement)?
    a) Yes
    b) No

5. When recommending other supplements (pre-work outs, creatine, b-alanine, multi-ingredient supplement) do you provide information or advice around WADA banned substance contamination risk management?
    a) When recommending supplements, I think the risk is low and don't recommend any process
    b) When recommending supplements, I provide advice that there is risk and to manage that risk use major brands or whole foods
    c) When recommending supplements, I advise the athlete to only use 3rd party audited products
    d) When recommending supplements, I advise the athlete to only use 3rd party audited products and check with the ASADA app
    e) When recommending supplements, I advise the athlete to only use 3rd party audited products by checking the ASADA app and encourage them to keep an independent register of their use including batch number

6. Do you recommend athletes use foods that contain added animal protein sources as an ingredient in your performance nutrition plans (whey, casein, isolates, blends powders)?
   a) Yes
   b) No

7. If yes do you associate any risk from WADA banned substance contamination with foods with the added animal protein?
   Likert 0-10 0 = extremely low risk, 5 somewhat risky, 10= extremely high risk

8. Do you recommend athletes use foods that contain added traditional plant protein sources as an ingredient in your performance nutrition plans (soy isolate, soy crisps)?
   a) Yes
   b) No

9. If yes do you associate any risk from WADA banned substance contamination with foods with the added plant protein?
   Likert 0-10 0 = extremely low risk, 5 somewhat risky, 10= extremely high risk

10. Do you recommend athletes use foods that contain added newer plant protein sources as an ingredient in your performance nutrition plans (hemp, pea, brown rice)?
    a) Yes
    b) No

11. If yes do you associated any risk from WADA banned substance contamination with foods with added newer plant protein?
    Likert 0-10 0 = extremely low risk, 5 somewhat risky, 10= extremely high risk

12. If you work for an NSO or NIN does your supplement policy outline the risk of contamination of dietary supplements with WADA banned substances?
    a) Yes, they recommend 3rd party certified products, and an independent supplement use registry including records of batch numbers
    b) Yes, they recommend athletes not use supplements
    c) Yes, they identify the risk and allow athletes to manage the risk independently
    d) No they have no reference to supplement risk
    e) No the sport does not have a supplement policy

Appendix B: Understanding contamination risk associated with protein fortified foods (PFF)

Athlete focus groups: face to face mode preferred over larger scale online survey.

Group Size: up to 6

Time: ~30minutes

Focus groups were used to provide a structure for drawing out opinions around the topic.

Original cohort approached: Queensland Rugby, Cricket Australia, Paddle Australia, Surfing Australia

Actual cohort interviewed: Swimming, Triathlon, Sprint Kayak, BMX.

Outline/Preamble

Protein powders and supplements that contain protein are commonly used by athletes to enhance training adaptations and recovery from strenuous workouts. There is a lot of awareness about the risks of supplements containing (purposefully or inadvertently) WADA banned substances. Organisations such as ASADA have worked hard at educating athletes about these risks and how to mitigate risk by choosing lower risk alternatives. Most recently food companies, online retailers, start-ups, café's and chain outlets are selling foods that contain 'added protein' to meet consumer demand for products with higher protein contents (protein supplemented foods). The use of protein supplemented foods amongst athletes and the associated risks are poorly understood.

We are interested to find out how extensive protein supplemented foods are consumed by athletes and if the risks associated with protein supplemented foods is similar to protein supplements.

2 Categories of PFF's

1. Foods and ready-prepared meals with plant origin protein from sources as ingredients (e.g. high protein cereal bar, fortified protein ball)
2. Foods and ready-prepared meals with animal origin fortified protein sources as ingredients (e.g. high protein cereal bar, baked goods)

Protein is typically added to foods as isolated dry-powdered animal sources: collagen powder, dairy (Whey derivatives; WPI, WPC, MPI, MPC, Non-fat milk solids) or plant sources (soy, pea, rice, hemp), however protein can also be added through nuggets or crisps.

Introduction to questions

"Risk" refers to contamination risk leading to a positive doping test (adverse analytical finding; AAF)

Disclaimer: Any data obtained will be de-identified and used for internal data collection purposes only.

1. Do you actively look to see if foods have added protein as ingredients?

   a) No

   b) Yes

   If yes, what foods would you look for added protein??

2. How would you rate (scale 1-10) your confidence in identifying a PFF?
   1 = not at all confident, 5 = somewhat confident, 10 = extremely confident

   1 2 3 4 5 6 7 8 9 10

3. How would you check if a product was fortified (supplemented) with protein? (front label, Nutritional information panel)

4. What are some examples of PFF you have seen/used previously?
   Examples: Carmen's Protein bars, Weet-Bix Protein cereal, Uncle Toby's Super Blends Protein cereal.

5. Do you consider these foods to be protein fortified foods?

6. In terms of WADA prohibited substances, what is the likely risk of each of the following products
   (circle answer – NO – No risk; LOW – Low Risk; MOD – Moderate Risk; High – High Risk)

7. In terms of WADA prohibited substances, do you think there is any difference in the risk profile of foods with added animal derived proteins (whey, collagen) compared to added plant proteins (soy, pea)? Please circle one answer
   a) Yes, animal sourced proteins are riskier than plant proteins
   b) Yes, plant sourced proteins are riskier than animal proteins?
   c) No difference
   d) Unsure

8. Do you see any **additional risk** associated with novel plant proteins such as hemp compared to more traditional plant protein sources such as Soy? Please circle answer
   a) Yes
   b) No
   c) Unsure

Part – 2 Oral Discussion

1. As an athlete, do you have higher daily protein requirements than a non-athlete?
   If yes, what are the main strategies you use to increase protein intake?

2. Do you feel protein added to foods is beneficial? If so, why? (marketing, convenience, taste, meeting protein requirements)

3. Are you currently using any PFF? If so, which ones?

4. Do you have any concerns using PSF? (risk, cost)

5. Overall, what level of "doping risk" do you think is associated with PSF?
   (Rate 0-10, where 0 = no risk, 5 = some risk, and 10 = high risk)

6. What do you think are the riskiest PFF's?

7. Do you deliberately avoid consuming PFF for the potential risk of contamination?

8. Do you use protein powders or drinks that contain WPI, pea protein, casein protein; liquid meal supplements such as Sustagen sport or protein containing sports foods i.e protein bars, protein balls etc? Yes / No

9. Do you use any processes to manage the risk of contamination of these products with WADA banned substances?

10. Do you use the ASADA app at all to check the status of your products before consuming them?

11. Do you use third party audited supplements? If yes, which ones?

Appendix C: Food manufacturer contamination risk audit (via Interview)

Bench audit of the current documented contamination risk processes food manufacturers are bound by law to undertake within Australia (e.g. HACCP and Allergen contamination processes)

Questions

1. How are your added protein ingredients sourced? Where from, Companies etc.
2. Are isolated protein ingredients (isolated whey, soy crisps) handled any different from other product ingredients?
3. Are "Plant Protein Blends" (Soy protein crisps, pea protein crisps, soy protein powder) which contain several proteins sourced as a blend or received as individual ingredients and blended once received?
4. Are Dairy proteins sourced from a large dairy supplier or third party distributer?
5. Does your company manufacture their own "Protein supplemented" products in a company owned facility or use a contract manufacturer?
6. If using a contract manufacturer, is your company aware of other products that are produced in the same facility?
7. In addition to the Ingredient manufacturers product data sheet (providing -Typical analysis, nutritional information and microbiological analysis) is there any additional in-house or external Quality control testing/analysis conducted with isolated protein ingredients before being added to a product formula.
8. What "Food safety programs" does the company currently comply with? HACCP, ISO:9001.
9. Under the HACCP system, are dairy derived proteins (whey, non-fat milk solids) controlled in the same way as plant-based proteins such as soy, pea, lupin or wheat?
10. Has the company ever conducted or considered getting isolated proteins tested by a third party company for contamination with WADA banned substances?
11. What level of contamination risk with WADA prohibited substances would you associate with your protein supplemented foods?

Appendix D: Protein-supplemented Café Food Survey

Date: **Café (include location):**

Take note of the menu, have a look on the counter, take a look in the fridge to see if there is any 'protein' foods/drinks available. Take note.

T*he café chef or manager may be the best person to question.*

As part of a project conducted by Kerry O'Bryan, Greg Shaw and Greg Cox (Accredited Practising Dietitians and Accredited Sports Dietitians) we are interested in understanding contamination risk associated with protein supplemented foods. The project has been funded by the Australian Institute of Sport Professional Networks headed by Alison Campbell (Professional Networks Manager).

Protein powders are increasingly being added to foods in cafés and retail outlets. Athletes are often instructed to avoid buying these foods due to the unknown risk associated with failing a doping test from consuming a product that has not been cleared of banned substances.

We are conducting a quick anonymous survey amongst local cafés to see if they use added protein in foods and where they source the protein from. Examples may include smoothies with added protein, protein balls or brownies with added protein or protein fortified pancakes.

Our research will add clarity to athletes use of such foods where protein is added at café retail outlets. Any information gathered will be strictly confidential and de-identified with no publishing of any business names. We would really appreciate if you could support our project and provide answers to our survey.

1. Do you add protein powders or crisps (eg: whey, hemp) to smoothies or other foods/fluids (i.e. bliss balls, pancakes)
    a) Yes
    b) No

2. Do you buy any foods/fluids with added protein powders (eg: bliss balls, brownies, juices)?
    a) Yes
    b) No

3. If yes, where do you purchase the protein from?
    a) Wholesale/foodservice distributor
    b) Supermarkets
    c) Online through a supplement retail store
    d) Online from a wholesale supplement store
    e) In bulk from a large commercial distributor

4. Do you buy raw (unflavoured) or flavoured protein powder? If so, from who?

5. Do you add any other functional powders as ingredients such as Maca Powder, Spirulina, Lion's Mane or branched chain amino acids?
    a) Yes
    b) No

Appendix E: Food Standards Australia New Zealand – Conditions for nutrition content claims (Protein)

Conditions for nutrition content claims			
Column 1	**Column 2**	**Column 3**	**Column 4**
*Property of food	General claim conditions that must be met	Specific descriptor	Conditions that must be met if using specific descriptor in Column 3
Protein	The food contains at least 5 g of protein/serving unless the claim is about low or reduced protein.	Good Source	The food contains at least 10 g of protein/serving.
		Increased	(a) The food contains at least 25% more protein than in the same amount of *reference food; and (b) The reference food meets the general claim conditions for a nutrition content claim about protein.

Appendix F: Sports Dietitian – Survey responses in relation to the doping risk of foods with added protein ingredients

Its hard to keep up with the food supply
We need a clearer approach here with more and more products coming on the market
Advise that the use of foods with added protein should be third party tested protein e.g. True, BSc, SiS
Quite often, higher protein foods are recommended to support recovery nutrition and meet convenience and practicality. However, the athletes are always aware that there is a small risk and where possible, they are advised through well - balanced meals and snacks, there protein needs should be achieved without the need for additional fortified protein foods (bars, balls)
Seems to be a growing area - thanks for taking this project on guys!
Unsure
The Australian Cricket Supplement Policy requires that a player avoid using foods with added protein unless approved as low risk by their Cricket Sports Dietitian. The player must present the product to the Dietitian, and the Dietitian then needs to contact the manufacturer to ascertain the origin if the added protein etc.. It is then the Dietitians decisioin as to whether the product is deemed low risk (and players advised of this and they can use or mod/high risk and must be avoided.
The greatest risk probably comes from people like me who have only a small sports portfolio and may not be connected to what the sport or network knows or is doing
contamination of protein and other novel ingredients sourced from third party factories or factories where multiple products produced from different brands is why i have exercised a degree of caution and our strict NSO supp policy
Source of the protein being clearly identifed
If our athletes are to take anything that includes a supplement we make sure it is third party tested. Anything that isn't we recommend to avoid even if the risk of consume that food product is low.
It is becoming more difficult to advise athletes with the supermarkets range of proteins with added protein becoming so diverse. e.g. muesli bars/yogurts/plant milk with added protein
I definitely think they are higher risk than batch-tested options but if we exclude them soon we will be excluding half of the supermarket and for athletes with high protein/energy needs that are juggling school/uni/work/training, these products can make a really useful option. Rokeby Farms is an example of a RTD shake that doesn't contain added protein so I prefer to recommend this one when looking at RTD beverages.
need to know more clearly on labels where the protein is grown, sourced from. Shouldn't have proprietary blends- we should know exactly what is in the product
I have contacted food companies (eg Carman's) to ask about where their protein is sourced, and at times the information provided back has cited a wide range of countries around the world as being 'possible' sources of the protein. I don't know how to advise athletes on this given I don't think the added protein indeed can effectively be tracked/monitored. If you don't 'monitor' this protein that's added into foods, does it make a mockery of the whole call to only use third party tested 'protein supplements'?

Supplementary Table 1. Protein fortified food details

					Product Details			
Description	**Manufacturer**	**Country of manufacture**	**Breadth of exposure**	**Type of food**	**No. of Isolated Proteins added**	**Isolated Protein added**	**Source of added protein**	**Protein nutrient claim on label**
Breakfast foods								
Kellog's Nutri-grain	Kellog's	Australia	Major Supermarkets, Independently owned stores	Cereal	1	Wheat protein	Plant	Yes
Protein Crunch	Freedom Foods	Australia		GF Cereal	1	Whey protein concentrate	Animal	Yes
Oats Super Blends Protein	Uncle Toby's	Australia		Cereal	1	Soy protein isolate	Plant	Yes
Weet-bix Protein	Sanitarium	Australia		Cereal	1	Pea protein crisps	Plant	Yes
Biscuits and snacks								
Breakfast Bakes	Uncle Toby's	Australia		Cereal bar	1	Wheat protein	Plant	No
Protein Popcorn	Freedom Foods (Crankt)	Australia	Coles	Cereal based snack	1	Whey protein concentrae	Animal	Yes
Gourmet Protein Bars	Carman's	Australia	Major supermarkets, Independently owned stores	Cereal bar	3	Soy protein crisps, Pea protein crisps, Soy protein powder	Plant	Yes
Protein Nut bars	Nice & Natural	New Zealand	Major supermarkets, Independently owned stores	Nut bar	1	Soy protein crisps	Plant	Yes
Protein bar	Tasti	New Zealand	Major supermarkets, Independently owned stores	Nut bar	1	Soy nuggets	Plant	Yes
Protein Nut bars	Nature Valley	Spain		Nut bar	2	Isolated soy protein, Whey solids	Animal and plant	Yes
YoPRO Protein Nut Bar	Danone	?	Major Supermarkets	High protein snack	2	Hydrolised collagen, Soy nuggets	Animal and plant	Yes
Dairy/Dairy Free								
Protein Bar	Streets	Australia	Major Supermarkets	Frozen dessert	1	Milk protein powder	Animal	Yes
Fro Pro Singles	FroPro	Australia	Woolworths supermarkets, Caltex Service stations	Frozen dessert	2	Skim milk concentrate, Milk protein concentrate	Animal	Yes
Snickers Protein Bar	Mars	United Kingdom	Supplement stores, Pharmacy.	High protein snack	5	Hydrolysed collagen, Milk protein isolate, Milk protein, Whey protein concentrate, Whey powder	Animal	Yes
YoPRO Diary Free	Danone	?		Dairy alternative	2	Soy protein, pea protein	Plant	Yes
Dairy free Vegan Creamy Cheese	Bute Island	Scotland	Supermarkets	Dairy alternative	1	Soy protein concentrate	Plant	No

Supplementary Table 1. Continued.

					Product Details			
Description	**Manufacturer**	**Country of manufacture**	**Breadth of exposure**	**Type of food**	**No. of Isolated Proteins added**	**Isolated Protein added**	**Source of added protein**	**Protein nutrient claim on label**
Health Foods								
Low Carb High Protein Bar	Body Science	Australia	Major Supermarkets, Independently owned stores, supplement stores		5	Wheat protein concentrate, calcium caseinate, whey protein isolate, soy protein isolate, Soy protein nuggests,	Animal and plant	Yes
Protein muffin	Macro	Australia	Woolworths brand	Cereal	1	Soy protein isolate	Plant	Yes
Low carb bar	Atkins	Netherlands	Major supermarkets, Amazon,	High protein snack	2	Soy crisps, Milk protein	Animal and plant	Yes
Protein energy ball	Bounce	USA	Major supermarkets	High protein snack	2	Whey protein concentrate, Whey protein hydrolysate	Animal	Yes
Protein Nut Bar	Freedom	Australia	Major supermarkets	High protein snack	2	Soy protein crisps, Soy protein isolate	Plant	Yes
Protein Bar	Crankt (Freedom Foods)	Australia	Major supermarkets	High protein snack	7	Protein blend (Soy protein isolate, whey protein isolate, hydrolysed collagen, calcium caseinate, whey protein concentrate, soy protein nuggets), soy protein isolate	Animal and plant	Yes
High Protein bar	The Bar Counter	Australia	Major supermarkets	High protein snack	4	Soy protein isolate, Whey protein isolate, Whey protein hydrolysate, Milk protein concentrate	Animal and plant	Yes
Vegan Jerky	K.M. Foods	Australia	Independently owned stores	Plant based Protein Snack	1	Soy protein	Plant	Yes
Bakery								
Protein Buttermilk Pancake mix	Greens	Australia	Coles	Bread	1	Soy protein isolate	Plant	Yes
85% Lower carb Higher Protein bread	Bakers Life	Australia	Aldi	Bread	3	Wheat protein, soy protein, lupin protein	Plant	Yes
Protein Bread Mix	PBCo.	Australia	IGA, Healthfood stores, Online	Bread	2	Whey protein, pea protein	Animal and plant	Yes
Herman Burger Protein Bun	Herman Brot	Australia	IGA, Healthfood stores, Pharmacies,	Bread	3	Wheat protein, Soy protein, lupin protein	Plant	Yes
Protein Donut Baking mix	Macro Mike	Australia	Select Woolworths, Supplement stores, Healthfood stores, Pharmacy, Gymnasiums, Cafes.	Bread	1	Almond protein	Plant	Yes
Frozen Meal								
Super Protein Wellness Bowl	Super Nature	Australia	Major Supermarkets	Frozen meal	2	Soy protein, Bovine collagen peptides	Animal and plant	Yes

Supplementary Table 2. Isolated Protein Sources and Origin

Protein		Product Name	Source	Type	Company	Origin
Animal derived						
Whey Proteins						
Native whey protein isolate	WPI	Prolacta 95 Instant	Dairy	Animal	Lactalis Ingredients	France
Hydrolised whey protein isolate						
Whey protein concentrate	WPC	Instantised WPC 80	Dairy	Animal	Fonterra	NZ
Dairy protein crisp	Whey	Sureprotein 600 Diary Protein Crisp (DPC) - 60% Protei	Dairy	Animal	Fonteraa	NZ
Whey protein isolate	WPI	ALECEN 894	Dairy	Animal	Fonterra	NZ
Whey protein isolate (Partially hydrolyzed)	WPI	Nutrasol 690	Dairy	Animal	Glanbia Nutritionals	USA, Wisonsin
Milk protein isolate	MPI	Promilk 85 (100-1)	Dairy	Animal	Tatura	Aust, Vic
Whey protein isolate	WPI	Saputo WPI - GP-92	Dairy	Animal	Gallo Protein	USA. California
Whey protein concentrate	WPC	SUNPRO Instant WPC 80	Dairy	Animal	Warrnambool Cheese & Butter factory Company	Aust, Vic
Whey protein isolate	WPI	Hilmar 9410 Instantized Whey Protein Isolate	Dairy	Animal	Hilmar Ingredients	USA. California
Whey protein isolate	WPI	Provon 292	Dairy	Animal	Glanbia Nutritionals	USA, Wisonsin
Whey protein concentrate	WPC	Avonlac 282	Dairy	Animal	Glanbia Nutritionals	USA, Wisonsin
Milk Protein Concentrates						
Milk protein isolate	MPI	Milk protein concentrate 4861	Dairy	Animal	Fonterra	NZ
Casein/Caseinates						
Calcium caseinate			Dairy	Animal		
Sodium caseinate			Dairy	Animal		
Milk Powders						
Skim milk powder			Dairy	Animal		
Whole milk powder			Dairy	Animal		
Skim/whey blend (economical)			Dairy	Animal		
Bovine collagen peptides			Animal	Animal	Gelita	
Plant derived						
Soy protein isolate				Plant		
Soy protein powder		SUPRO Soy Protein	Soy	Plant	Dupont Nutrition & Biosciences	
Soy protein				Plant		
Soya protein concentrate				Plant		
Soy protein crisps (soy protein, tapioca starch, salt)				Plant		
Soy protein nuggets (isolated soy protein, cocao powder, tapioca starch)		SUPRO NUGGETS Soy Protein Nuggets	Soy	Plant	Dupont Nutrition & Biosciences	
Pea protein isolate		Nutralys pea XF exp - F85F, F85M, F85G, S85F.	Vegetable Pea	Plant	Roquette	France
Textured pea protein		Nutralys T65M	Vegetable Pea	Plant	Roquette	France
Rice protein concentrate		Organic Oryzatein Silk80 (available in 70/80/90% protei	Vegetable Rice	Plant	Axiom Foods	USA. California
Pea protein crisps (peap protein concentrate, rice flour, rice starch)				Plant		
Organic pea protein crisps				Plant		
Pea protein isolate		Vegotein (50/75/80% protein)	Vegetable Yellow pea	Plant	Axiom Foods	USA. California
Wheat protein				Plant		
Hemp seeds				Plant		
Lupin protein				Plant		
Pumpkin seed protein						Australia

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