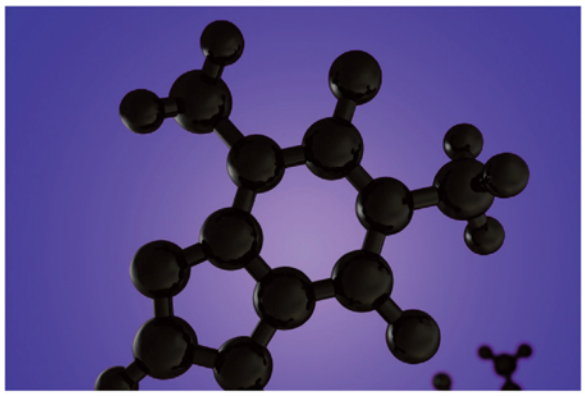
Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2010-2011 Targeted Surveys

Chemistry



Progesterone in Butter, Cheese and Cream

TS-CHEM-10/11

Canada

Table of Contents

Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and enhance Canada's food safety system. As a part of the FSAP enhanced surveillance initiative, targeted surveys are used to test various foods for specific hazards.

The main objective of the progesterone in butter, cheese and cream targeted survey was to generate baseline surveillance data on the levels of progesterone in domestic and imported butter, cheese and cream available on the Canadian retail market.

Health Canada's Veterinary Drug Directorate evaluates the safety of veterinary drugs administered to food-producing animals and sets standards for the amount of residues in primary edible tissues (e.g., muscle, liver, kidney and fat) and primary products of animal origin (e.g., eggs, milk and honey). Some veterinary drugs containing progesterone have been approved in Canada and the USA for use in lactating dairy cattle. They are used therapeutically primarily to synchronize reproductive cycles in order to time artificial insemination. Hormonal growth promoters approved for use in beef cattle in Canada (including progesterone) are not approved for use in dairy cattle in Canada[a]. In Canada, no maximum residue limits have been established for natural hormones in milk or milk-derived products.

Since progesterone is fat-soluble, there is a strong correlation between the levels of progesterone and the milk fat content of dairy products. Therefore, this targeted survey focussed on butter, cheese and cream, all of which have pronounced fat content. In total, 259 butter, 247 cheese and 231 cream samples were collected from Canadian retail stores and were analyzed for the steroid hormone progesterone. Samples included primarily domestic butter and cream and both imported and domestic cheese. All of the samples had detectable levels of progesterone. This is not unexpected given that progesterone is naturally produced by cattle.

In general, the average progesterone levels in the current survey were comparable to those reported in scientific literature on hormones in food. The slightly higher detected levels of progesterone in certain cheeses may, in part, be due to the different types and fat content of cheeses sampled and the more sensitive analytical methods used in the current survey.

Results of this targeted survey were shared with both the Veterinary Drugs Directorate and the Bureau of Chemical Safety of Health Canada. The levels of progesterone observed in this survey are unlikely to contribute significantly to the overall exposure of Canadians to this hormone. Based on consultation with Health Canada, no health risk to Canadians was identified based on the results of the survey. Follow-up activities were not deemed necessary given that no elevated levels of concern were found.

[a] This targeted survey analyzed both domestic and imported dairy products. While progesterone is not approved for use as a growth promoter in Canada, the CFIA cannot be certain of the veterinary practices in all countries.

1 Introduction

1.1 Food Safety Action Plan

In 2007, the Canadian government launched a five-year initiative in response to a growing number of product recalls and concerns about food safety. This initiative, called the Food and Consumer Safety Action Plan (FCSAP), aims to modernize and strengthen the food safety regulatory system. The FCSAP initiative unites multiple partners in ensuring safe food for Canadians.

The Canadian Food Inspection Agency's (CFIA) Food Safety Action Plan (FSAP) is one element of the government's broader FCSAP initiative. The goal of FSAP is to identify risks in the food supply, limit the possibility that these risks occur, improve import and domestic food controls, and identify food importers and manufacturers.

Within FSAP there are 12 main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess, and prioritize potential food safety hazards through risk mapping, information gathering, and testing of foods from the Canadian marketplace. Targeted surveys are one tool used to test for the presence and level of a particular hazard in specific foods. Targeted surveys are largely directed towards the 70% of domestic and imported foods that are regulated solely by the *Food and Drugs Act* and *Regulations,* and are generally referred to as non-federally registered commodities.

1.2 Targeted Surveys

Targeted surveys are pilot surveys used to gather information regarding the potential occurrence of chemical residues in defined commodities. The surveys are designed to answer specific questions. Therefore, unlike monitoring activities, testing of a particular chemical hazard is targeted to commodity types and/or geographical areas.

Due to the vast number of chemical hazards and food commodity combinations, it is not possible, nor should it be necessary, to use targeted surveys to identify and quantify all chemical hazards in foods. To identify food-hazard combinations of greatest potential health risk, the CFIA uses a combination of scientific literature, media reports, and/or a risk-based model developed by the Food Safety Science Committee (FSSC), a group of federal, provincial and territorial subject matter experts in the area of food safety.

Steroid hormones control a range of physiological processes. Mammals naturally produce and metabolize steroid hormones as well as ingest them through their diet.

As part of the CFIA's core activities, some dairy commodities are currently being monitored under the National Chemical Residue Monitoring Program (NCRMP) for the presence of steroid hormones. Targeted surveys focus mainly on those products not monitored under the NCRMP. The purpose of this targeted survey was to establish

baseline data on progesterone levels in more finished dairy products (i.e., butter, cheese and cream) available in the Canadian marketplace. The scope of this survey is complementary to NCRMP monitoring of hormone residues in cheese but includes additional commodities (i.e., butter and cream) not routinely monitored.

1.3 Acts and Regulations

The *Canadian Food Inspection Agency Act* stipulates that the CFIA is responsible for enforcing restrictions on the production, sale, composition and content of foods and food products as outlined in the *Food and Drugs Act* and *Regulations*.

Health Canada establishes maximum levels for chemical residues and contaminants in food sold in Canada. Some veterinary drugs containing progesterone have been approved in Canada and the USA for use in lactating dairy cattle[1,2]. Progesterone is one of several hormones used primarily to synchronize reproductive cycles in order to time artificial insemination of dairy cattle and in the treatment of reproductive issues. Progesterone and other natural (testosterone and estradiol-17ß) and synthetic hormones (trenbolone acetate, zeranol and melengestrol acetate) currently approved in Canada for use as growth promoters in beef cattle are not approved for use in dairy cattle in Canada[b]. However, no Canadian maximum levels have been established for natural hormones in food[3].

Health Canada's position regarding maximum residue limits for progesterone is harmonized with the Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives (JECFA) which confirmed that it was unlikely that progesterone residues would pose a hazard to human health when used in accordance with good animal husbandry practice. JECFA has established an acceptable daily intake (ADI) for progesterone of 0-30 µg/kg body weight[4].

2 Survey Details

2.1 Rationale

Steroid hormones are known to pass the blood-milk barrier[5]. Progesterone is normally found at higher levels in milk and dairy products compared to other animal-derived products[6]. However, the progesterone levels in many foods (e.g., meat, milk, eggs, fish) are extremely low compared to those naturally produced by humans[6]. Since progesterone is fat-soluble, there is a strong correlation between the levels of progesterone and the milk fat content of dairy products[6]. Therefore, this targeted survey focussed on butter, cheese and cream, all of which have pronounced fat content.

A review of hormonally active compounds in food concluded that the ingestion of natural steroid hormones from food is not expected to have hormonal effects, since they are

[b] This targeted survey analyzed both domestic and imported dairy products. While progesterone is not approved for use as a growth promoter in Canada, the CFIA cannot be certain of the veterinary practices in all countries.

poorly absorbed and more than 90% of such hormones are inactivated by the liver[5]. As identified in a recent review of hormones in meat-producing animals, data on naturally-occurring (i.e., produced by the cow) levels of steroid hormones in dairy products would facilitate comparison and identification of elevated levels of these compounds in retail food samples[7].

Based on data from Statistics Canada, the Canadian Dairy Information Centre calculated that approximately 8.2 L of cream[8], 2.7 kg of butter and 12.5 kg of cheese were consumed per Canadian in 2010[9].

Given the consumption of butter, cheese and cream by Canadians and their marked fat content, this targeted survey was designed to establish baseline data on progesterone levels in these dairy products available to Canadians.

2.2 Sample Distribution

In this survey, a total of 737 samples of dairy products were collected from grocery and specialty stores in 11 Canadian cities across eight provinces between October 2010 and March 2011. The samples included 259 butter, 247 cheese and 231 cream products.

Two hundred and fifty nine butter samples were collected and analyzed. The distribution of butter samples by type is shown in Figure 1.

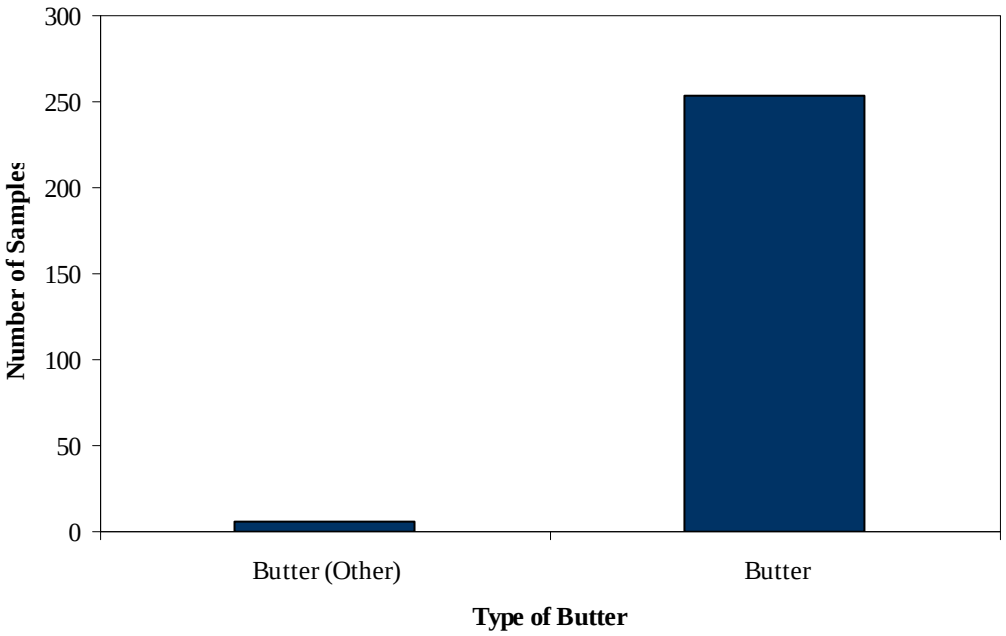


Figure 1. Distribution of butter samples by type.
Butter refers to 253 salted and unsalted, cultured, whipped and garlic-flavoured butters. Butter (Other) refers to six butter samples including goat milk butter, clarified butter, and spreadable butter containing canola oil.

A wide variety of cheese types were collected but it was not possible to unequivocally categorize the samples. Cheese varieties are often grouped according to texture, moisture and fat content, source of the milk (i.e., animal species), ageing, production method, and origin; however, no single method of classification is universally used. The grouping most commonly used is based on moisture content, which is then followed by fat content and ripening method. A general description of some of the categories of cheeses sampled in this survey is summarized in Table 1[10].

Table 1. Approximate fat content of cheese and typical examples.

Approximate fat content of cheese	Description	Examples of cheeses by fat content
0.5-30%	Fresh (coagulated) or stretched curd ("Fresh")	Ricotta, curds, cottage, paneer, cream, quark, Neufchâtel, mascarpone, chèvre, bocconcini, haloumi, mizithra
20-32%	Soft-ripened ("Soft")	Brie, Camembert, feta, blue, Gorgonzola
24-31%	Semi-hard washed ("Semi-soft")	Colby, Gouda, brick, Edam, fontina, Havarti, Munster, raclette
21-34%	Hard (low temperature) ("Semi-hard")	Oka, mozzarella, Cheddar, provolone, Manchego, Emmental, Gruyère, Tilsit
25-30%	Hard (high temperature) ("Hard")	Parmesan, Asiago, Romano, Swiss, pecorino
N/A	"Processed"	Label indicates processed cheese product

A total of 247 cheese samples were collected and analyzed. All samples were derived from cow's (bovine) milk or from a mixture of both bovine and non-bovine milk. The distribution of cheese samples by type is shown in Figure 2.

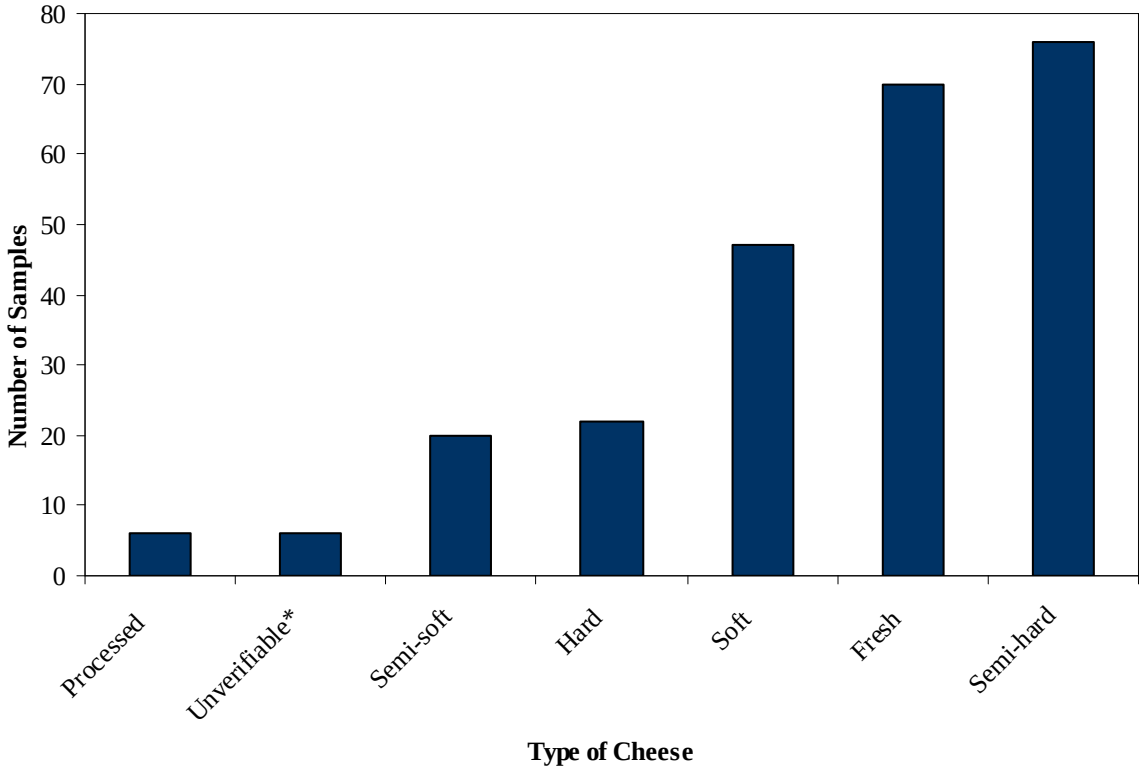


Figure 2. Distribution of cheese samples by type.
* Unverifiable refers to samples for which type could not be determined based on the label or sample description.

A total of 231 cream samples were collected and analyzed, including half and half, table, whipping and sour cream. The distribution of cream samples by type is shown in Figure 3.

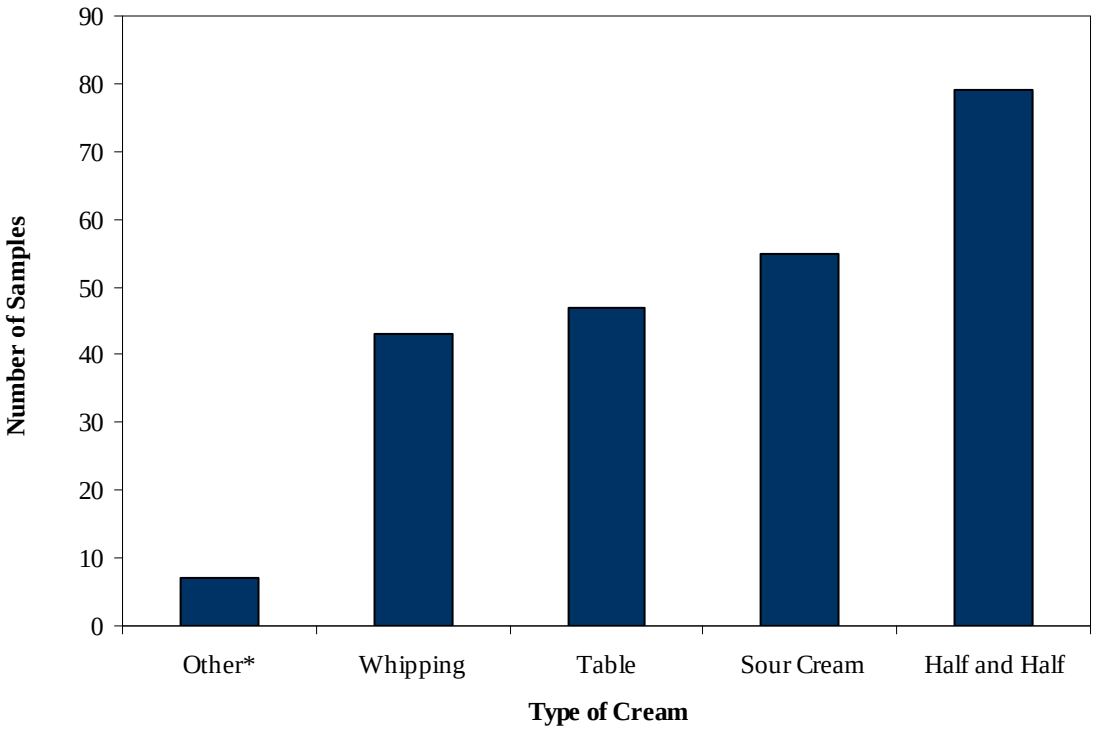


Figure 3. Distribution of cream samples by type.
* Other refers to light and thick cream samples as well as those for which cream type could not be determined based on the label or sample description.

Samples collected included primarily domestic butter and cream, and both imported and domestic cheese. The distribution of butter, cheese and cream samples by country of origin (as recorded by the sampler or indicated on the label) is presented in Table 2.

Table 2. Distribution of butter, cheese and cream samples by country of origin. Countries are listed in order of decreasing quantity of total samples.

Country of Origin	Butter	Cheese	Cream	Total
Canada	252	127	222	601
France	1	27	0	28
Netherlands	0	16	1	17
USA	4	13	0	17
Denmark	0	13	2	15
Italy	0	13	0	13
United Kingdom	0	9	3	12
Switzerland	0	10	0	10
Norway	0	8	0	8
Germany	0	6	0	6
Ireland	0	3	0	3
Unverifiable*	0	0	3	3
Israel	2	0	0	2
Finland	0	1	0	1
Portugal	0	1	0	1
Total	259	247	231	737

*Unverifiable refers to those samples for which country of origin could not be determined from the label or sample information.

2.3 Method Details

Butter, cheese and cream samples in the progesterone targeted survey were analyzed by a laboratory under contract with the Government of Canada. Contracted laboratories are accredited to ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (or its equivalent) by the Standards Council of Canada.

The laboratory used a liquid chromatography with tandem mass spectrometry method to analyze and confirm steroid residues in the dairy products samples. This multi-residue method tests for multiple hormones including progesterone, testosterone, epi-testosterone, 19-nortestosterone, epi-19-nortestosterone, alpha-trenbolone and beta-trenbolone. As progesterone was the hormone of interest in this survey, results for the other analytes found (i.e., testosterone and epi-testosterone) are presented in Appendix A.

The limits of detection (LOD) and limits of quantitation (LOQ) for the method used in this survey for the three hormone analytes are listed in Appendix B.

2.4 Limitations

The progesterone targeted survey was designed to provide a baseline of the levels of progesterone in butter, cheese and cream available for sale in Canada and had the potential to highlight commodities that warranted further investigation. Regional differences, impact of product shelf-life, packaging and storage conditions, or cost of the commodity on the open market were not examined in this survey. Country of origin was assigned for all but three samples (designated "Unverifiable" in Table 2) based on information provided by the sampler or indicated on the label.

3 Results and Discussion

The levels of progesterone found in samples in this survey are presented and discussed below. As indicated above, please refer to Appendix A for a summary of testosterone and epi-testosterone levels found in the survey samples.

3.1 Progesterone in Butter

A total of 259 butter samples were collected and analyzed, including 253 salted and unsalted, cultured, whipped and garlic-flavoured butters, and six other butters including goat milk butter, spreadable butter containing canola oil and clarified butter. As presented in Table 2, most of the butter samples (252 of 259) were of domestic origin. All samples contained progesterone (Table 3). Progesterone levels in butter samples in this survey ranged from 0.044 ppm to 0.260 ppm, with an average of 0.146 ppm.

Table 3. Summary of minimum, maximum and average progesterone levels found in butter samples.

Product Type	Number of Samples	Number of Samples with Progesterone Found	Minimum Progesterone Level (ppm)	Maximum Progesterone Level (ppm)	Average Progesterone Level (ppm)
Butter	253	253	0.067	0.260	0.147
Butter (Other)*	6	6	0.044	0.141	0.082
Butter Total	**259**	**259**	**0.044**	**0.260**	**0.146**

* Butter (Other) samples include goat milk butter, spreadable butter containing canola oil and clarified butter.

The average progesterone level found in butter samples in the current survey was comparable with those reported in a scientific literature review of hormones in food (0.133 to 0.300 ppm, average)[5]. Based on the consumption of butter per Canadian and the average progesterone levels reported in this survey, a person would be exposed to considerably less than the ADI established by the JECFA[4], even assuming the worst case scenario.

3.2 Progesterone in Cheese

A total of 247 cheese samples were collected and analyzed. A wide variety of cheese was sampled, and given that no single method of classification is universally used, the grouping was based on approximate moisture/fat content as described in Table 1[10]. Cheese categories included fresh/curd ("Fresh", e.g. cottage, curds, ricotta), soft-ripened ("Soft", e.g. Brie, Camembert, feta), semi-hard washed ("Semi-Soft", e.g. Edam, Havarti, raclette), hard low-temperature ("Semi-Hard", e.g. Oka, Cheddar, Emmental), and hard high-temperature ("Hard", e.g. Asiago, Romano, Parmesan). Many artisan-style cheeses were included in each category. "Processed" cheese samples included those that indicated processed cheese product on the label.

All of the 247 cheese samples contained detectable levels of progesterone (Table 4). Progesterone levels in cheese samples in this survey ranged from below the LOQ to 0.276 ppm, with an average of 0.079 ppm.

Table 4. Summary of minimum, maximum and average progesterone levels found in cheese samples.

Cheese Type	Number of Samples	Number of Samples with Progesterone Found	Minimum Progesterone Level (ppm)	Maximum Progesterone Level (ppm)	Average Progesterone Level (ppm)
Processed	6	6	0.046	0.276	0.104
Semi-hard	76	76	0.036	0.152	0.092
Unverifiable*	6	6	0.026	0.092	0.076
Soft	47	47	0.015	0.127	0.074
Semi-soft	20	20	0.035	0.093	0.072
Fresh	70	70	0.004	0.192	0.071
Hard	22	22	0.001	0.137	0.068
Cheese Total	**247**	**247**	**0.004**	**0.276**	**0.079**

* Unverifiable refers to samples for which type of cheese could not be determined based on the label or sample description. Product types are arranged in decreasing order of average progesterone levels.

The three highest progesterone levels were found in a processed smoked gouda (0.276 ppm), a spiced, fresh cream cheese (0.192 ppm) and a mature cheddar (0.152 ppm), all of imported origin.

Processed cheese contained both the highest maximum level (0.276 ppm) and highest average level (0.104 ppm) of progesterone of the types of cheese tested. Hard cheese contained the lowest average progesterone level (0.068 ppm) of the cheese types tested. There did not appear to be a clear relationship between the approximate fat content of the assigned cheese category and the level of progesterone (Tables 1 and 4); however, the fat content was not recorded for each sample and the fat content ranges overlap considerably between categories.

The average progesterone level in cheese sampled in the current survey was higher than those for cheese reported in a scientific literature review on hormones in food (0.001 to 0.044 ppm, average)[5]. This may, in part, be due to the different types of cheese sampled and the more sensitive analytical methods used in the current survey. Since the types and numbers of cheese tested in CFIA's targeted survey were different than those reported in the literature review, it is not unexpected that the progesterone levels are different.

Based on the consumption of cheese per Canadian and the average progesterone levels reported in this survey, a person would be exposed to considerably less than the ADI established by the JECFA[4], even assuming the worst case scenario. Based on consultation with Health Canada, no health risk to Canadians was identified based on the results of this survey.

3.3 Progesterone in Cream

All of the 231 cream samples contained progesterone (Table 5). Progesterone levels in cream samples in this survey ranged from 0.004 ppm to 0.167 ppm, with an average of 0.051 ppm. Samples of whipping cream (0.166 ppm) and half and half cream (0.167 ppm) contained the highest progesterone levels and whipping cream had the highest average level (0.086 ppm) of progesterone of the types of cream tested. The results are not unexpected given the strong correlation between percentage fat and progesterone concentration in milk[11].

Table 5. Summary of minimum, maximum and average progesterone levels found in cream samples.

Cream Type	Number of Samples	Number of Samples with Progesterone Found	Minimum Progesterone Level (ppm)	Maximum Progesterone Level (ppm)	Average Progesterone Level (ppm)
Whipping Cream	43	43	0.027	0.166	0.086
Table Cream	47	47	0.007	0.118	0.056
Cream (Other)*	7	7	0.017	0.109	0.055
Half and Half Cream	79	79	0.018	0.167	0.042
Sour Cream	55	55	0.004	0.083	0.034
Cream Total	**231**	**231**	**0.004**	**0.167**	**0.051**

***** Cream (Other) refers to light and thick cream samples as well as those for which cream type could not be determined based on the label or sample description. Product types are arranged in decreasing order of average progesterone levels.

The average progesterone level found in cream samples in the current survey was comparable with those reported in a scientific literature review on hormones in food (0.042 to 0.073 ppm, average)[5]. Based on the consumption of cream per Canadian and the average progesterone levels reported in this survey, a person would be exposed to considerably less than the ADI established by the JECFA[4], even assuming the worst case scenario.

4 Conclusions

The present survey generated baseline surveillance data on the levels of progesterone in domestic and imported butter, cheese and cream available on the Canadian retail market. No maximum limits have been established in Canada for natural hormones in milk or milk-derived products such as butter, cream and cheese.

In total, 259 butter, 247 cheese and 231 cream samples were collected and all had detectable levels of progesterone. This is not unexpected given that progesterone is both naturally produced and is an approved hormone for use in cattle in Canada and many other countries. Lactating cows synthesize a large quantity of progesterone naturally which fluctuates depending on the reproductive cycle of the animal. Based on Health Canada's assessments, the approved use of progesterone in lactating cows would result in only a slight increase in exposure compared to naturally-occurring levels. As progesterone is fat-soluble, it was not surprising that dairy commodities high in fat (i.e., butter) had the highest average progesterone level compared to cheese and cream.

The average progesterone levels in the current survey were comparable to those reported in a scientific literature review on hormones in food for butter and cream and slightly higher than those reported for cheese. This may, in part, be due to the different types of cheese sampled and the more sensitive analytical methods used in the current survey. However, the levels of progesterone in butter, cheese and cream detected in this survey were low and will expose consumers to only a small fraction of the safe intake levels established by the JECFA.

All data was shared with the Health Canada's Veterinary Drugs Directorate and Bureau of Chemical Safety. Based on Health Canada's safety assessment process for natural steroid sex hormones (e.g., progesterone), the use of progesterone-containing drugs would result in minimal increases in exposure, if any, compared to naturally-occurring levels of progesterone. The progesterone levels in many foods, including dairy products, are extremely low compared to those naturally produced by humans, are poorly absorbed and the majority of hormones absorbed from the diet are inactivated by the liver. Follow-up activities were not deemed necessary given that no elevated levels of concern were found. The levels of progesterone observed in this survey are unlikely to contribute significantly to the overall exposure of Canadians to this hormone. Based on consultation with Health Canada, no health risk to Canadians was identified based on the results of this survey.

5 References

[1] North American Compendiums. *Compendium of Veterinary Products* [online]. 2012. Accessed May 29, 2012, http://cca.naccvp.com/index.php?.

[2] United States Food and Drug Administration. *FDA Approved Animal Drug Products* [online]. 2012. Accessed May 29, 2012, http://www.accessdata.fda.gov/scripts/animaldrugsatfda/.

[3] Health Canada. *Questions and Answers – Hormonal Growth Promoters* [online]. 2005. Accessed May 18, 2012, http://www.hc-sc.gc.ca/dhp-mps/vet/faq/growth_hormones_promoters_croissance_hormonaux_stimulateurs-eng.php.

[4] Codex Alimentarius Commission. *Maximum Residue Limits for Veterinary Drugs in Foods.* [online] July 2011. Accessed April 26, 2012, http://www.codexalimentarius.net/vetdrugs/data/MRL2_e_2011.pdf.

[5] Fritsche, S., and Steinhart, H. Occurrence of hormonally active compounds in food: a review. *European Food Research Technology*. [online]. 209:153-179 (1999). Accessed May 4, 2012, http://www.springerlink.com/content/dwc283k3p9afwebp/fulltext.pdf.

[6] Hartmann, S., Lacorn, M., Steinhart, H. Natural occurrence of steroid hormones in food. *Food Chemistry*. [online]. 62(1):7-20 (1998). Accessed April 26, 2012, http://dx.doi.org/10.1016/S0308-8146(97)00150-7.

[7] Scarth, J., Akre, C., van Ginkel, L., Le Bizec, B., De Brabander, H., Korth, W., Points, J., Teale, P., and Kay, J. Presence and metabolism of endogenous androgenic-anabolic steroid hormones in meat-producing animals: a review. *Food Additives and Contaminants*. 26(5): 640-671 (2009).

[8] Canadian Dairy Information Centre. *Per Capita Consumption of Milk and Cream.* [online]. 2012. Accessed May 10, 2012, http://dairyinfo.gc.ca/pdf/camilkcream.pdf.

[9] Canadian Dairy Information Centre. *Per Capita Consumption of Dairy Products in Canada* [online]. 2012. Accessed May 10, 2012, http://www.dairyinfo.gc.ca/pdf/dpconsumption.pdf.

[10] University of Guelph. Food Science. Dairy Science and Technology. *Introduction to Cheese Making*. [online]. Undated. Accessed April 12, 2012, http://www.foodsci.uoguelph.ca/cheese/sectiona.htm#Table1_2.

[11] Ginther, O.J., Nuti, L.C., Garcia, M.C., Wentworth, B.C., and Tyler, W.J. Factors Affecting Progesterone Concentration in Cow's Milk and Dairy Products. *Journal of Animal Science* [online]. 42:155-159 (1976). Accessed May 1, 2012, http://jas.fass.org/content/42/1/155.full.pdf.

Appendix A

Testosterone was not found in any of the 259 butter samples analyzed.

Table A2. Summary of minimum, maximum and average testosterone levels found in cheese samples.
* Unverifiable refers to samples for which type of cheese could not be determined based on the label or sample description. † Minimum, maximum and average testosterone levels were calculated from samples with testosterone. Product types are arranged in decreasing order of average testosterone levels.

Product Type	Number of Samples	Number of Samples with Testosterone Found	Minimum Testosterone Level (ppm)	Maximum Testosterone Level (ppm)	Average† Testosterone Level (ppm)
Semi-hard	76	53	0.001	0.003	0.002
Hard	22	2	0.001	0.002	0.001
Semi-soft	20	17	0.001	0.002	0.001
Soft	47	32	0.001	0.002	0.001
Unverifiable*	6	5	0.001	0.002	0.001
Fresh	70	10	0.001	0.001	0.001
Processed	6	0	<LOQ	<LOQ	<LOQ
Cheese Total	**247**	**119**	**0.001**	**0.003**	**0.001**

Table A3. Summary of minimum, maximum and average testosterone levels found in cream samples.
* Cream (Other) refers to light and thick cream samples as well as those for which cream type could not be determined based on the label or sample description.
† Minimum, maximum and average testosterone levels were calculated from samples with testosterone. Product types are arranged in decreasing order of average testosterone levels.

Product Type	Number of Samples	Number of Samples with Testosterone Found	Minimum Testosterone Level (ppm)	Maximum Testosterone Level (ppm)	Average† Testosterone Level (ppm)
Sour Cream	55	9	0.001	0.001	0.001
Table Cream	47	1	0.001	0.001	0.001
Half and Half Cream	79	0	<LOQ	<LOQ	<LOQ
Whipping Cream	43	0	<LOQ	<LOQ	<LOQ
Cream (Other) *	7	0	<LOQ	<LOQ	<LOQ
Cream Total	**231**	**10**	0.001	0.001	0.001

Table A4. Summary of minimum, maximum and average epi-testosterone levels found in butter samples.

* Butter (Other) samples include goat milk butter, spreadable butter containing canola oil and clarified butter. † Minimum, maximum and average epi-testosterone levels were calculated from samples with epi-testosterone.

Product Type	Number of Samples	Number of Samples with Epi-Testosterone Found	Minimum Epi-Testosterone Level (ppm)	Maximum Epi-Testosterone Level (ppm)	Average† Epi-Testosterone Level (ppm)
Butter	253	243	0.001	0.002	0.001
Butter (Other)*	6	1	0.001	0.001	0.001
Butter Total	**259**	**244**	**0.001**	**0.002**	**0.001**

Table A5. Summary of minimum, maximum and average epi-testosterone levels found in cheese samples.

* Unverifiable refers to samples for which type of cheese could not be determined based on the label or sample description. † Minimum, maximum and average epi-testosterone levels were calculated from samples with epi-testosterone.

Product Type	Number of Samples	Number of Samples with Epi-Testosterone Found	Minimum Epi-Testosterone Level (ppm)	Maximum Epi-Testosterone Level (ppm)	Average† Epi-Testosterone Level (ppm)
Semi-hard	76	52	0.001	0.001	0.001
Hard	22	10	0.001	0.001	0.001
Semi-soft	20	7	0.001	0.001	0.001
Soft	47	6	0.001	0.001	0.001
Unverifiable*	6	1	0.001	0.001	0.001
Fresh	70	6	0.001	0.001	0.001
Processed	6	0	<LOQ	<LOQ	<LOQ
Cheese Total	**247**	**82**	**0.001**	**0.001**	**0.001**

Table A6. Summary of minimum, maximum and average epi-testosterone levels found in cream samples.

* Cream (Other) refers to light and thick cream samples as well as those for which cream type could not be determined based on the label or sample description.

† Minimum, maximum and average epi-testosterone levels were calculated from samples with epi-testosterone.

Product Type	Number of Samples	Number of Samples with Epi-Testosterone Found	Minimum Epi-Testosterone Level (ppm)	Maximum Epi-Testosterone Level (ppm)	Average† Epi-Testosterone Level (ppm)
Sour Cream	55	1	0.001	0.001	0.001
Table Cream	47	1	0.001	0.001	0.001
Half and Half Cre	79	2	0.001	0.001	0.001
Whipping Cream	43	11	0.001	0.001	0.001
Cream (Other) *	7	1	0.001	0.001	0.001
Cream Total	**231**	**16**	0.001	0.001	0.001

Appendix B

Table B1. Limits of detection and limits of quantitation for the three hormone analytes detected in this survey.

	Limit of Detection (LOD) (parts per million (ppm))	Limit of Quantitation (LOQ) (ppm)
Progesterone	0.001	0.003
Testosterone	0.0005	0.001
Epi-Testosterone	0.0005	0.001