Cottage cheese in a diet - A review

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Purpose: Cottage is a protein-rich food which is commonly consumed by people targeting weight reduction and athletes willing to to eat whole-food instead of protein supplements. Yet out of common knowledge, the scientific community lacks solid evidences of the effect of the inclusion of cottage cheese in a diet. The objective of this study was to assess the evidences from scientific literature of the impact of inclusion of cottage cheese in a diet.

Literature screening: PubMed and Web of Science were searched for scientific literature dealing with "cottage cheese" and "diet". There was no restriction regarding the type article type, date nor journal it is published in. References found to during the analysis of the articles extracted from database were also included. Studies search, screening and eligibility analysis were led in parallel by two independent reviewers.

Findings: This survey shows that cottage cheese is a good source of calcium (with 83 mg/100g) - but not low fat cottage cheese because of its low vitamin S content ($p < 0.001$) -, a source of probiotic (1 serving providing the RDI), a source of high quality proteins, reduces postprandial blood glucose level - healthy and type II diabetes subjects - ($p < 0.05$), is not linked to increased cardiovascular diseases nor cancer risks ($p < 0.05$).

Originality: Based on the findings reported in this review, the inclusion of cottage cheese in a diet can be advised for: women to build up calcium storage to fight osteoporosis; more generally calcium/vitamin D deficient subjects; athletes willing to increase their high quality proteins intake through whole food consumption; dieters looking for low energy, high protein, high satiety food; untreated type II diabetes patients by reducing postprandial glucose level.

Cottage cheese | Low-fat cottage cheese | Diet | Calcium intake | Protein intake

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1. Introduction

Cottage cheese is a dairy product belonging to the soft cheese category. It can be found in many regions of the world, sometimes under different names and variations (the most knwon being perhaps *ricotta* in Italy, *skyr* in Iceland, *fromage blanc*, in France, *qwark* in Netherlands, *paneer* in India). Even though its origin is not known precisely, it is thought to come out of Britain. Its name comes from its rural origins as it was initially produced in by farmers in towns and villages (1). Industrial production of cottage began in the US during the first World War. Over time, it has become a popular dairy product, backed by a dynamic industry (2).

From a food processing point of view, cottage cheese is produced by acidification of milk, leading to a protein (caseins) coagulation. In contrast to rennet coagulation, in the case of cottage cheese, the clusters remain loose, giving a soft texture to the product. In more detail, the productions process starts with the pasteurization of raw skim milk. It is then cooled down to 32 °C. Then coagulation is triggered either by adding culture or acid. Once the coagulation has been achieved the coagulum is cut in rough squares which size will determine the curd size (0.62 cm for small curd, 1.86 cm for large curds). The curd is then cooked at 54 °C for at least one hour and a half. Continuous stirring prevents curd pieces clustering. Afterwards, the heating system is turned off and the whey is drained. The curd is water-washed before being let to drain. Finally, depending on the desired product, it is blended with salt and optionally cream. The product is then packaged ad stored at 4 °C. It has a typical shelf-life of 3 to 4 weeks (3–5).

From a nutritional perspective (Tab. 1 and 2), cottage is a protein-rich food with a protein content ranging from 8 to 12 g/100g of proteins - mainly caseins - (6). Its lipids content can vary much, from 0 g for no fat cottage cheese, up to 8 g/100g for full fat cottage cheese - several other variations exist, e.g. 2 % fat, ...-. Its carbohydrate content is almost constant around 4 g/100g, no mater the amount of fat nor protein. The carbohydrates originate from milk intrinsic sugars (lactose). Cottage cheese also contains trace elements, part from sodium, the most present is calcium (around 83 mg/100g). Furthermore its energy density is relatively low, less than 100 kcal/100 g. When retailed in stores, one serving of cottage cheese is about 100 $\simeq$ 120 g. Its presentation makes it readily edible (can be consumed *directly out of the box*) and easy to dress up. Nevertheless, besides common knowledge, nutrition professionals lack scientific evidences advocating for or against the inclusion of cottage cheese in a diet.

By reviewing the scientific literature, the present article aims at filling this gap.

2. Nutritional qualities of cottage cheese

Findings are divided according to their topic. Concerning cohorts study, their objectives and design can be found in Table 3 as well as their results specific to cottage cheese consumption. One should also not a potential bias that could affect this review. Most of the authors did not report the precise composition of the cottage cheese used. When the use of a low-fat product was not specified, cottage cheese was considered as regular, unsweetened cottage cheese.

2 1. Population consuming cottage cheese

Cottage cheese is a popular dairy product among the population, and is usually associated with better health condition (lower all-cause death rate, $p = 0.005$ (11), lower rate of

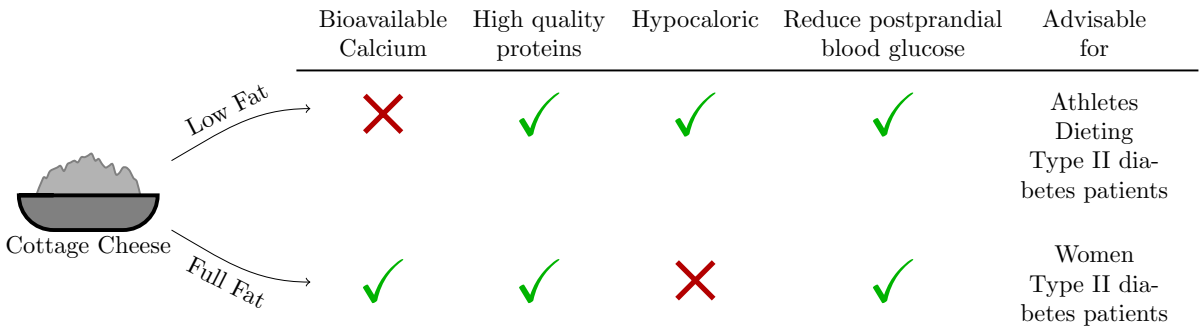

Fig. 1. Beneficial aspects of cottage and the populations it is advisable for

Proximate components	Unit	Cottage cheese, creamed	Cottage cheese, no fat
Water	g/100g	79.79	81.01
Energy	kcal/100g	98	72
Protein	g/100g	11.12	10.34
Total lipid (fat)	g/100g	4.3	0.29
Fatty acids, total saturated	g/100g	1.718	0.169
Fatty acids, total monounsaturated	g/100g	0.778	0.079
Fatty acids, total polyunsaturated	g/100g	0.123	0.003
Carbohydrate, by difference	g/100g	3.38	6.66
Fiber, total dietary	g/100g	0	0
Sugars, total	g/100g	2.67	1.85

Table 1. Proximate composition of creamed cottage cheese and no-fat cottage cheese. Source: USDA Food Composition Databases

Minerals & Vitamins	Unit	Cottage cheese, creamed	Cottage cheese, no fat
Calcium, Ca	mg/100g	83	86
Iron, Fe	mg/100g	0.07	0.15
Magnesium, Mg	mg/100g	8	11
Phosphorus, P	mg/100g	159	190
Potassium, K	mg/100g	104	137
Selenium, K	µg/100g	0.022	NA
Sodium, Na	mg/100g	315	372
Zinc, Zn	mg/100g	0.4	0.47
Vitamin C, total ascorbic acid	mg/100g	0	0
Thiamin	mg/100g	0.027	0.023
Riboflavin	mg/100g	0.163	0.226
Niacin	mg/100g	0.099	0.144
Vitamin B-6	mg/100g	0.046	0.016
Folate, DFE	µg/100g	12	9
Vitamin B-12	µg/100g	0.43	0.46
Vitamin A, RAE	µg/100g	37	2
Vitamin E (alpha-tocopherol)	mg/100g	0.08	0.01
Vitamin D (D2 + D3)	µg/100g	0.1	0
Vitamin K (phylloquinone)	µg/100g	0	0

Table 2. Proximate composition of creamed cottage cheese and no-fat cottage cheese. Source: USDA Food Composition Databases, (7, 8). NA - Not Available

second-line chemotheraty in the case of ovarian cancer, p = 0.003 (19)). Though, from available studies in the US and East Europe, it is consistently consumed more by women than men (20–22). Age distribution of the consumption favors young (< 25 year old) and elder (> 65 year old) (23). Regarding low-fat cottage cheese, which is generally regarded as less appealing than its full-fat counterpart (24), it is consumed by two subsets of the general population:

- people with BMI>25 kg/m^2 and dieters ($p < 0.05$, (12, 16)),
- people adopting an healthy lifestyle (e.g. non smoker, physically active, ...) ($p < 0.05$, (14, 16)).

Low-fat cottage cheese popularity among dieters can be explained by its low energetic value and high satiating effect (25). Yet given its low quantity of bioavailable calcium it does not contribute to this particular population in achieving its calcium Recommended Dietary Intake (RDI)($p < 0.001$ (12)).

Ref	Cohort design†	Study design	Objective	Main findings
(9)	IRAS, n = 1624, 40-69y, 5.2y	n = 880, healthy & T2D, blood samples & clinical measurements	Assessing dietary patterns associated with T2D	CC consumption was higher in the T2D population ($p < 0.0001$)
(10)	NHS II, n = 116671, women, 25-42y, 16y+	n = 47355, questionnaire	Investigating a link between teenage acne and diet	CC consumption years was higher among women facing acne flares during teenage ($p = 0.03$)
(11)	MONICA France, men, 18y+, 15y	n = 991, 45-64y, clinical measurements	Associating food groups and risk of death	CC is evidenced to reduce chance of death with 1+ serving per day ($p = 0.005$)
(12)	BCS70, n = 2754, women	n = 1158, 16-17y, questionnaire	Assessing dietary patterns associated with dieting	Dieting group eat almost twice as much CC as non-dieting participants, yet it was not statistically significant
(13)	IRAS, n = 1624, 40-69y, 5.2y	n = 1088, healthy & T2D, blood samples & clinical measurements	Associating dietary habits with carotid artery atherosclerosis	CC consumption is associated with higher carotid intima-media thickness, an indicator of coronary heart diseases ($p < 0.0001$)
(14)	MONA LISA, n = 4827, 35-74y, 2y	n = 3071, 35-64y, questionnaire, SCORE equation	Assessing the difference between low-fat and high-fat dairy products in terms of cardiovascular risk	Low-fat dairy (including LFCC) products are associated with better lipid profile, healthier habits and lower cardiovascular diseases for high risk profiles ($p < 0.001$)
(15)	14 cohorts compilation	n = 319732 men, 542948 women, questionnaire	Assessing the link between dairy products and pancreatic cancer	CC, as well as dairy products in general, is not statistically associated with increased pancreatic cancer risks ($p = 0.06$)
(16)	Belgian military cohort, n = 5000	n = 1852, questionnaire	Investigating the determinant for low-fat food consumption	Low-fat food, including LFCC, consumption is associated with two populations: BMI>25 kg/m^2 & people adopting an healthy lifestyle ($p < 0.05$)
(17)	STANISLAS, 4000+, 28-60y, 24y+	n = 588, blood samples & clinical measurements, 5y follow up	Assessing the relation between dairy product consumption and metabolic syndrome	Consumption of milk, CC, yogurt reduced diastolic blood pressure ($p = 0.003$), fasting glucose ($p = 0.025$) and increase HDLC (men BMI<25 kg/m^2, $p = 0.046$, not significant for men BMI>25 kg/m^2, $p = 0.319$)
(18)	SUN cohort, n = 15909 (in 2006), 20-90y	n = 8063, 6+, questionnaire	Assessing th link between diet and diseases and/or chronic conditions	Low fat dairy (including LFCC) products reduces the occurrence of hypertension ($p < 0.05$)

Table 3. Compilation cohorts studies, name, design and objectives, as well as results associating cottage cheese consumption and related effect on human health. Abbreviation: CC = cottage cheese, LFCC = low-fat cottage cheese, BCAA = branched-chain amino acids, T2D = type II diabetes, n = number of participants, 16y+ = 16-year-old or older
Superscripts: †Given as: name, total number of participant, characteristic (age, women/men, ...), follow-up period (when applicable).

2 2. Trace elements in cottage cheese

From its composition table, cottage can be seen as a source of different trace elements. The two main ones are calcium and sodium.

2.2.1. Cottage cheese as a source of calcium. Literature is conflicting when trying to determine whether cottage cheese can be considered as a good source of calcium. Some studies have shown that:

- cottage cheese to significantly increases both calcium and phosphorous fixation compared to other proteins (meat and soy) (26),
- also reduces the chances of hips fracture by 82.6 % ($p = 0.00$, this impressive figure has to be moderated by the fact that Indian population, studied here, has a very low basal calcium level), while milk effects are not statistically significant (27),
- it also lowers calcium renal tubular reabsorption more than other protein sources, in post-menopausal women, yet this effect is only minor (28)
- it is the main supplier of calcium for some populations (female nutrition faculty student, here) (29).

While a product analysis has determined that:

- low-fat cottage cheese is a poor source of calcium, with less than 30 mg of calcium per 100 kcal and less than

30 mg of calcium per serving (30). Contradictory to what can be found in the USDA Food Composition Databases.

2.2.2. Sodium concerns. The high level of sodium in cottage, around 0.3 g/100g, gives rise to concerns about its potential detrimental effect on human health (31). Sodium is added to the final product for both taste and shelf-life extenstion (32) as its pH , around 5, does not prevent microorganisms growth (3). Recent reseaarch efforts have been led to reduce sodium content and replace it with other minerals. Yet preserving the product organoleptic properties and subsequent consumers appeal is a challenge (33, 34).

2 3. Bacterial microbiota

Cottage cheese probiotic content is higher than 10^6-10^7 CFU/g (35). Besides, probiotic cultures grow inside of the product before declining. The optimal time of consumption is within 8 days after its preparation (36).

The prediminant species are *Lactococcus lactis spp lactic*, constituting around 44 % of the population (37). *Lactococcus lactis* ssp. *cremoris* and *Lactobacillus casei* spp are also present in sizable amounts (3). One should note thath the composition of the microbiota population varies depending of the production location around the workld (37). Furthermore, the product composition can be manipulated to favor probiotic targeted culture, such as *Bifidobacterium animalis* ($delta$ log cfu of 1.5 over 25 day, p-value < 0.05), with only minimal effect on consumer acceptance (38). The addition of D vitamins is another beneficial manipulation that does not alter composition ($p < 0.05$, (39)).

2 4. Metabolic response to cottage cheese ingestion

2.4.1. In healthy subjects. Cottage cheese ingestion was shown to lower postprandial blood glucose level, increase insulin level (through branched-chain amino acid insulin production triggering) (25, 28, 40). Cottage cheese proteins have a high bioavailability, as shown by serum amino acid level and overall fixation (41), notably higher than milk or egg proteins ($p < 0.05$, (42)).

In addition, cottage cheese consumption has been associated with acne flares among teenage women in a cohort study ($p = 0.03$ (10)). The authors hypothesized that this was due either to cottage cheese vitamin D content or hormonal content.

Finally, it has recently been shown that among dairy products, cottage cheese and milk consumption were associated with higher total cerebral cortex volume (male, $p = 0.005$, and female, $p = 0.025$), and higher total cerebral white matter (men, $p = 0.006$) (43). The author did not argue whether it was beneficial or not and offer as explanation that casein (main protein of cottage cheese) has a propensity to cross the blood brain barrier.

2.4.2. In Type II diabetes patients. In untreated type II diabetes patients, cottage cheese addition to a meal reduces postprandial glucose level as well as overall 24 hours integrated glucose level. Furthermore, it increases insulin and glucagon level ($p < 0.05$, (44–46)), in a magnitude superior to other protein sources. These effects have not been observed for type II diabetes patients under treatment ($p > 0.05$, (47)).

In contrast, a cohort study found an association between type II diabetes and cottage cheese consumption ($p < 0.0001$, (9)). Yet the same author hypothesize in a latter article (13) that it might be due to confounding as cottage cheese would be consumed in association of with other foods, such as refined sugars.

2 5. Cottage cheese and cardiovascular/cancer risks

In cohort studies, cottage cheese is associated with reduced CVD risks ($p < 0.05$ (17)), hypertension ($p < 0.05$, (18)) and cancer risk ($p = 0.0023$, (48), while not significant in another study $p = 0.06$, (15)). In addition, low-fat cottage cheese consumption is linked a lower LDL cholesterol level and hypertriglyceridaemia occurence ($p < 0.001$, (14)) as well as CVD risks lowering for initially high risks subjects ($p < 0.001$, (14)).

Yet a diverging finding can be noted (13), where cottage cheese consumption is associated with higher CVD risks ($p < 0.0001$). Nevertheless, the authors strongly doubt of their findings and explained it by the association of cottage cheese with other less healthy foods when consumed.

3. Discussion

Regarding calcium, the two apparently diverging opinions can be reconciled by considering the difference in product nature. Indeed, regular cottage cheese (referred simply as *cottage cheese*) is rich bioavailable vitamin D and D3 (49), making calcium fixation all the more easy. On the contrary, given the fact that vitamin D is stored with the lipids, low-fat cottage cheese is poor in vitamin D (49) and cannot be considered as a good source of calcium.

Cottage cheese microbial population has been shown to belong to the probiotic group (35, 37). Scientific community recommends an intake of about 10^8-10^9 CFU/day of probiotics (50) to get full benefit from their consumption. With a content around 10^6-10^7 CFU/g, a 100 g serving contains enough microbiota to reach scientific recommendations.

Given the animal fat and hormones content of cottage cheese, it is sometimes thought to be related to cardiovascular diseases (CVD) and/or cancer risks. Yet consistent evidences show that its consumption is not related with increased CVD/cancer risks (15). Furthermore, the consumption of low-fat cottage cheese is associated with a better lipid profile (14).

In addition to having positive effect on the general population, the present review compiles evidences of the interest of adding cottage cheese in type II diabetes patients. Indeed, its consumption during meals naturally lowers postprandial blood glucose levels. Authors have hypothesized that this effect would come from its protein compositions (44).

Based on the current scientific findings, the consumption of cottage cheese is advised for the following populations for different reasons: women to build up calcium storage to

fight osteoporosis; more generally calcium/vitamin D deficient subjects; athletes willing to increase their high quality protein intakes through whole food consumption (low-fat); dieters looking for low energy, high protein, high satiety food; untreated type II diabetes patients by reducing post-prandial glucose level. These findings are summarized graphically in Figure 1.

Disclosure

The authors declare no conflicts of interest. They both have contributed equally to this work.

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