

# An Army Marches on Its Stomach?

By [Anthony L. Dawson](#) B.Sc (Hons) Dip. PT M.Res

This paper attempts to assess the rations of the Napoleonic French army (1800-1815) from a nutritional and health standpoint. This will enable a nutritional assessment of an 'average' Napoleonic soldier to be attempted and conclusions drawn as to the health and fitness of a that individual.

Napoleon Bonaparte, Emperor of the French, is supposed to have famously quipped than an 'army marches on it's stomach.' Whilst in essence this is true: an army cannot fight, let alone march with an empty stomach, how full were the stomachs of the *Grande Armée*?

The 'average' non-active male requires approximately 2,000 calories per day, with a recommended daily allowance (RDA) of 250g carbohydrate; 70g protein; 66-100g of fats. These are termed 'macronutrients'. The average male also requires 'Micronutrients' (vitamins, minerals).

The French Army ration c.1800 consisted of bread, meat, wine or beer and lard.

Bread (made from 3 parts rye flour to 1 part wheat): 750g (to last two days)  
Fresh Meat (theoretically beef): 300g  
Salted Meat (beef or bacon): 250g  
Biscuit (in lieu of bread): 550g  
Wine: 1 litre

## 1. Nutritional Content

### Bread

Rye Bread provides up to 260 calories per 100g. Per 100g it provides 48g carbohydrate (of which sugars 3.8g); 8g protein; 3.3g fats.

It also provides the following micronutrients:

Vitamin A	0%	Vitamin C	0%
Calcium	7%	Iron	15%
Vitamin D	0%	Vitamin B-6	5%
Vitamin B-12	0%	Magnesium	10%

Therefore a 750g loaf would provide approximately 1900 calories and 360g carbohydrate; 60g protein and 24g fats.

'Hardtack' made from flour and water (and a pinch of salt) can contain up to 100 calories per 10g. Therefore 550g of hardtack could provide 500 calories (approximately).

### Meat

The fresh beef would contain up to 250 calories per 100g. Per 100g 'good quality' beef steak provides 25g of protein and 15g of fats.

It also provides the following micronutrients:

Vitamin A	0%	Vitamin C	0%
Calcium	1%	Iron	14%
Vitamin D	1%	Vitamin B-6	20%
Vitamin B-12	43%	Magnesium	5%

Many of these macro- and micronutrients are destroyed through the cooking process:

- Stewed beef steak provides up to 200 calories per 100g and 25g protein and 14g fats
- Slow-cooked beef (Casserole or stew) provides up to 98 calories; 9.87g protein and 3.37g fats.
- Fried beef provides up to 220 calories per 100g; 27g of protein and 12g fats

The salted meat would have a lower nutritional content: it provides up to 125 calories per 100g and 24g of protein and 3g of fats. It provides 0% of RDA micronutrients.

Therefore, 300g of stewed beef steak would provide 600 calories, 75g protein and 42g fats. In comparison salt beef (commonly issued on campaign) would provide only 312 calories, 60g protein and 7 or 8g of fats.

### **Alcohol**

Red wine provides up to 85 calories per 100g and 2.8g of carbohydrates (via sugars). It provides 0% of RDA micronutrients. This would provide 'empty' calories – i.e. those calories which have a high calorific content but a very low nutritional value.

No water is listed in the rations but a water canteen was issued which held 2 litres. Vinegar was also issued as a crude disinfectant. An average male weighing 70kg requires 2.5 litres of water per day. Under moderate exercise dehydration can be up to 1litre per hour and under stress or high intensity exercise 2 to 3 litres of water per hour.

## **2. Towards a Nutritional Assessment**

### **Macronutrients**

The Calorific Content of the French Army ration would provide approximately 1550 calories per day: 950 calories from bread and 600 from the meat. This presents a calorific deficit of approximately 500 calories for an 'average' male and a calorific deficit of 1,000 calories for an 'active' male.

Comparison of rations with RDA for an 'average' male based on a 2,000 calorie diet shows

Carbohydrate	= RDA 250g.	Ration 180g
Protein	= RDA 70g.	Ration 75g
Fats	= RDA 66-100g.	Ration 66g

In other words, whilst French soldiers were probably eating sufficient protein they were not eating sufficient carbohydrate or fats. The litre of wine (1,000 grams) would have provided an additional 850 calories and 28g of carbohydrates (sugars).

If figures for salt meat, which was typically issued on campaign, are substituted we see an even greater deficit.

Carbohydrate	= RDA 250g.	Ration 180g	Campaign 180g
Protein	= RDA 70g.	Ration 75g	Campaign 60g
Fats	= RDA 66-100g.	Ration 54g	Campaign 32g

In other words, food issued on campaign when physical activity levels are higher and calorific and nutritional demands are therefore greater, was in fact of a lower calorific and nutritional value than that issued in barracks.

### **Micronutrients**

Where the micronutrients were not destroyed in any cooking process, French soldiers would have been lacking essential micronutrients.

It would have provided upwards of

- 60% RDA of Calcium
- 3% RDA vitamin D
- over 100% RDA Vitamin B-12
- 50% RDA Iron
- 80% RDA Vitamin B-6
- 45% RDA Magnesium

It provide 0% Vitamin A; 0% Vitamin C.

This would suggest that French soldiers via their ration alone were deficient in Vitamins A, C and D. This would have lowered their immune system and made them more prone to diseases such as scurvy (Vitamin C) and measles (Vitamin A). They may have fatigued quickly due to a lack of Iron (anaemia) and Magnesium (which can lead to muscle cramps and muscle fibres becoming easily damaged).

### **Estimated Calorific Requirements**

Analysis of a random sample of 400 individuals from the Grenadiers of the Imperial Guard entering that unit 1810-1812 suggests an average height of 1m 75; the tallest individual was 1m 88 and the shortest 1m 59. The average age was 29 years.

Therefore for an individual meeting those statistics, they would have an optimum weight of 55-65kg and a daily calorific requirement of 2,500 calories. Given that the army ration was approximately 1,000 calories below this requirement, it can be suggested that individuals would be sub-optimum weight. This, in turn, would reduce calorific requirements.

In order to walk (unloaded) 1km, at an average speed of 6km/h, an 'average' male would require 80 calories. Therefore to march for one hour 480 calories would be consumed, or approximately one third of the daily calorific intake through the rations alone. In a three-hour march a soldier would require their entire daily calorific intake via rations. However, because Napoleonic soldiers were accustomed to long marches (endurance performance) their ability to do so would be increased and their calorific requirement for such activity reduced.

### 3. Comparison with other armies

According to James 'A new and enlarged military dictionary' (1805), the British army ration consisted of:

Bread	1.5lbs (680g)
Meat (beaf or pork)	1lb (453g)
Peas	3/4 pint (0.4 litres or 400g)
Cheese or Butter	1oz 28g
Rice	1 oz 28g

It is immediately obvious that the British army ration of the same period was larger, with considerably more bread and meat than the French army ration. The meat provided approximately 900 calories and the bread ration over 1,000 calories!

Comparison of British and French bread and meat rations with RDA

Carbohydrate	=RDA 250g	British 300g	French 180g
Protein	= RDA 70g	British 110g	French 75g
Fats	= RDA 66-100g	British 55g	French 66g

In addition, British soldiers were issued with peas (high in vitamin C – lacking in the French ration), cheese and butter (the latter being sources of protein, fats and calcium).

- 100g of green peas can provide up to 80 calories and 5g protein as well as the following micronutrients, but many (most?) would be destroyed in the cooking process (usually boiling):

Vitamin A	15%	Vitamin C	66%
Calcium	2%	Iron	8%
Vitamin D	0%	Vitamin B-6	10%
Vitamin B-12	0%	Magnesium	8%

- 28g (1oz) of cheese provides up to 89 calories and 4.3g of protein and 7.7g of fats.
- 28g (1oz) of butter provides up to 172 calories and 0.2g of protein and 20g of fats and the following micronutrients:
- Rice is of a very low nutritional value: 28z (1oz) can provide up to 32 calories and 6.6g of carbohydrate, 0.6g protein and 0.2g fat.

Total calorific input of the British ration would have been approximately 2,000 calories.

### 4. Osteological Study

Lack of essential macro- and micro-nutrients is observable through osteological study; three recently excavated Napoleonic mass-graves (Valencia (2009) Vilinus (2002-2004), Erfurt (2004) have provided evidence for skeletal changes made to Napoleonic soldiers from poor diet and non-ergonomic equipment. By far the best-studied grave was that at Valencia; the excavations at Vilinus focused the artefactual assemblage.

173 individuals were examined from the grave at Valencia; 167 (of 65.5%) were positively identified as being males; eight individuals (4.6%) were aged below 25 years; 151 individuals (87.3%) aged between 25 and 45 years and one individual was older than 45 years. The average height was 1m70.

Two subjects amongst the 25-45 year age group demonstrated Porotic hyperostosis which is usually an indicator for sustained iron deficiency.

Some 70% of the individuals demonstrated Osteoporosis, especially in long bones (Femur, Tibia, Fibia, Humerus) suggesting malnutrition: low dietary calcium and/or phosphorus, magnesium, zinc, boron, iron, fluoride, copper, vitamins A, K, E, C and D. Smoking tobacco is also considered a risk factor for Osteoporosis.

Several individuals also presented intra-discal hernias (herniated disc): this would have led to chronic-lower back pain due to a pinched or compressed nerve. Such herniated discs can be due to either a sedentary lifestyle with poor posture (unlikely for Napoleonic soldiers) or poor posture caused by carrying heavy weight, or abnormal weight, over a prolonged period.

The grave at Erfurt excavated a total of 3,269 in three trenches over a two year period. Due to poor preservation, it was only possible to positively sex and age 70% of the individuals: of this 70%, 96.7% were males and 3.2% were females.

Estimation of age for the males revealed 3% were aged 18 years or younger; 93.5% were aged between 18 years and 40 years and 3.4% were aged over 40. The female population was aged over 40 years. The male skeletons revealed the presence of syphilis or tuberculosis and spinal problems.

The grave at Erfurt excavated 120 individuals, aged between 17 and 25 years.

## **5. Conclusion**

Hunger would have been a common experience for the soldiers of Napoleon's army: they had a caloric deficiency between 500 and 1,000 calories. They would have been below optimal weight and more prone to disease and infection due to reduced immune systems from a lack of essential micronutrients. By comparison with British soldiers they were underfed by approximately 500 calories.

Napoleon's soldiers would have felt permanently fatigued. This was because of substrate depletion due to lack of stored energy (as carbohydrate). The body can store around 2,000 calories in muscle tissue, the liver and extra-cellular fluid. When an individual is subsisting on a sub-optimum diet and exercising hard (long marches, for example) this stored carbohydrate becomes depleted; liver and muscle glycogen levels decrease, which in turn lowers blood glucose levels. This can lead to a sensation of being permanently fatigued, raises the production of the stress hormone cortisol and a trailing off in performance.

Such a low caloric diet and low carbohydrate diet would lead to weight loss through depletion of lean muscle mass and also through dehydration: for every gram of carbohydrate stored in the body, there is an obligatory gain of 2.6g of water. This would decrease blood volume and pressure, decrease lung and heart capacity, impair

thermoregulation and decrease performance. The litre of wine would not help, as alcohol is a diuretic: it increases the production of urine and encourages the reduction of water storage leading to dehydration.

Reduction in performance due to a lack of macronutrients would have been compounded through various micronutrient deficiencies. For example a deficiency in Magnesium would lead to increased muscular fatigue, muscular weakness and cramps. This would obviously impair the ability of a soldier to march for long periods. Magnesium also plays an important role in carbohydrate metabolism, and a magnesium deficiency can worsen insulin retention, a condition which precedes diabetes. Magnesium can also be inhibited by excessive alcohol consumption. Muscular fatigue and cramps due to a magnesium deficiency would be compounded through a deficiency in Iron and also Vitamins C and D. This would also lead to poor teeth, and poor or inhibited wound healing.

In order for French soldiers to survive any length of time on campaign they would have been forced, largely through hunger, to forage. For example, 1kg of potatoes would add to the meal 820 calories, providing around 14g protein; around 197g of carbohydrate and around 1g of fats.

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