# Are vegetarian meals truly healthier?

**Abigail Strefeler** abigail.strefeler@epfl.ch
**Léo Sumi** leo.sumi@epfl.ch
**Jérémy Alexandre** jeremy.alexandre@epfl.ch

## Abstract

**We all know that overeating is a big issue. However, with more and more people going on a diet or becoming vegetarian, we decided to investigate how this type of meal compares, in terms of nutrient profile, to meals containing meat, poultry, or fish. The profiles of major nutrients were compared across these meal types and with recommended values. We find that a balanced diet with reduced meat and poultry seems like the surest way to ensure health.**

## 1 Introduction

Vegetarian and vegan diets are promoted as healthier alternatives to the usual omnivorous diet. In the United States in particular, we often hear about the excessive quantities of meat consumed (1). However, being vegetarian may require more care to ensure that adequate amounts of certain nutrients are still present in the diet. We decided to investigate one aspect of the health impact of different diets: their nutrient profiles. The FDA, USDA, and NIH release regular guidelines about the quantities of nutrients to consume daily (2). Following these recommendations, geared towards the standard 2000 calories diet, is supposed to promote health and well-being. We chose to examine four major meal categories: dishes containing meat, fish/seafood, poultry, or vegetarian dishes containing none of the above. Macronutrient profiles can be compared with recommended values as the percent of total calories of the recipe. Vitamin and mineral recommendations are only provided daily, but we can still compare the meal types between themselves. We hope that by comparing nutrient profiles we can provide insights into how to balance different meal types to successfully meet health recommendations.

## 2 Data Collection

To get a good representation of the meals people eat, we use data from allrecipes.com. This website also provides easy access to both the list of ingredients and complete nutrition information for each recipe.

The semi-interactive platform ParseHub was used to get the list of URL corresponding to three categories of recipes: brunch, dinner, and vegetarian. We expect these categories to cover the main meals eaten in a day. A custom web scraper took the URL and used Beautiful Soup to parse the specific HTML code from allrecipes.com. Using this function, we obtained ingredient and nutrient information for the recipes.

Later on, while analyzing, we realized that total calories were not included in the scraped data. This value was located in a different part of the HTML code so was ignored. We judged that it made more sense to recalculate calories rather than to scrape again, since scraping is a long process and can result in being blocked by the website's server.

## 3 Data Analysis Methods

Analysis of the data followed several steps. First the scraped data had to be cleaned and a large set with all the recipes was created. From this complete data set, we separated the recipes into meal types as containing meat, fish/seafood, or poultry, or as containing none of the above (defined as vegetarian). Once we had these categories, we could compare their nutrient profiles. Since macronutrients can also be compared with recommended values, a special function converted total fat, protein, and carbohydrate amounts into kilocalories. This allowed us to compare their percentage of total energy of the recipe to the recommended percentage of total daily energy intake.

### 3.1 Cleaning Data

The first step to data analysis is cleaning and understanding the data. Scraped data from allrecipes.com were originally stored separately based on the category they were taken from (brunch, dinner, or vegetarian subsections of allrecipes.com). The data was kept in this format for preliminary cleaning so they were easier to view.

One aspect of cleaning involved converting the column with the amount of each nutrient into float values. For this, the corresponding unit first had to be deleted. We examined a highly variable nutrient (Sodium) and confirmed that the unit was constant throughout the data, so had no worries in deleting these characters.

Three types of dataframes were finally created for the combined recipe categories. One of these contained the nutrition information, one contained the recipe names and URL corresponding to those with nutrition information, and finally one contained the list of ingredients in the recipes. All of these sets of data were linked using the recipe ID.

### 3.2 Meal Types

We separated the recipe data into four categories based on the typical types of meals: those containing meat, fish/seafood, or poultry, or vegetarian dishes containing none of the above. Custom text files were created containing words specific to each of these first three categories. Using these files, we could extract the recipes containing meat, fish/seafood, or poultry. In the opposite way, we could extract recipes lacking any of these keywords, creating a vegetarian dataset as well.

Out of the 3110 recipes collected, we found 1502 to be vegetarian, 836 to contain meat, 597 to contain fish or seafood, and 455 to contain poultry. We see that in total this would add up to 3400 recipes, but we expect some overlap, caused for example by surf & turf, or the use of chicken broth or bacon in many different types of recipes.

### 3.3 Converting to Calories

We had originally hoped to compare the nutrient profiles of these different meal types also with the recommended values. This proved to be difficult, since the nutrition information for recipes is given per serving while the recommended values are given daily. There is no standard definition of what a serving is, it depends on the type of food, so we cannot consistently compare these values. We were able to find a way around this constraint in the case of the three main macronutrients (protein, carbohydrates, and total fat). The NIH provides recommended values for each of these molecules as percentage of total caloric intake (3). Very simple equations convert grams of the three macromolecules into calories, and their sum is equal to the total calories in the recipe.

$$\text{Fat [kcal]} = 9 * \text{Total Fat [g]}$$

$$\text{Carbohydrates [kcal]} = 4 * \text{Carbohydrates [g]}$$

$$\text{Protein [kcal]} = 4 * \text{Protein [g]}$$

Therefore we calculated, for each meal type, to what percentage they contributed to the total energy of each recipe.

$$\text{Percentage of contribution} = 100 * \frac{\text{nutrient in kcal}}{\text{total calories}}$$

We could then make a comparison with the recommended value as the extent to which they should contribute to the total energy.

## 4 Results

We tested how different nutrient profiles compared across the four main types of meal. In the cases of fat, carbohydrates, and protein, we could also compare with recommended dietary intake.

Unsurprisingly, different meal types differed some in terms of the percentage of fat that contributed to the total energy of the dish (Fig. 4). The distribution maximum for fat contribution is around 40% for vegetarian and fish dishes, while it is closer to 55-60% for meat and poultry dishes. However, regarding the recommended percentage of fat, which is 20-35% of total caloric intake (3), all recipe types have an excess of fat. While vegetarian and fish dishes do reduce the percentage of fat consumed, dietary improvements would clearly have to come from another source than simply modifying the type of meal.

The extent to which protein contributed to the total energy of a recipe varied across the meal types (Fig. 4). The distribution maximum for vegetarian dishes is right at the lower limit of the recommended percentage, 10%. Fish recipes surprisingly show a maximum that is even lower,

around 5%, but has a wider distribution so many recipes still fall into the recommended zone. Meat and poultry recipes show maxima around 20-30%. They fall nicely into the upper half of the recommended contribution of 10-35% (3). From this data we can see that vegetarian and fish dishes have a higher risk of protein deficiency. Since most meat and poultry dishes do not have an overdose of protein, keeping them in the diet seems like a good idea to keep protein levels up.

The contribution of carbohydrates to total energy varies widely, without clearly defined maxima (Fig. 4). Generally speaking, the different meal types remain on the low side of the recommended 45-65% (3). Meat and poultry dishes in particular show a gentle peak around 20%. Fish shows a hill between 25 and 40%. Vegetarian recipes show the highest values between 35 and 60%. Because of the very wide distributions, it is difficult to make conclusions about carbohydrate intake. However we can still see that meat and poultry dishes rarely show the recommended contribution and are often much lower than these values. These types of dishes should be balanced with others that contain more carbohydrates to meet recommended intakes.

Other nutrients could not be compared with recommended values, since these are given daily but we have quantities per serving. However, we still noticed some interesting differences between the four meal types under study, notably comparing the means of their distributions. We do remember that without being able to compare with recommended values, all of these observations are relative, and may ultimately be without importance.

One common health concern in recent years has been sodium levels. We would think that different diets would show variation in the amount of salt that they contain. This was indeed the case (Fig. 2). The lowest levels of sodium were found in vegetarian dishes, followed by fish/seafood dishes, and meat and poultry dishes. Being unable to compare with recommended values, it is difficult to say how these differences may contribute to daily sodium intake. However, someone trying to lower the amount of salt in their diet would do better to consider primarily vegetarian recipes.

A less well-known but surprisingly common nutrient deficiency in the Western world is magnesium (4). One way to combat magnesium deficiency is by eating leafy greens, however we see that purely vegetarian dishes have lower levels of magnesium than those containing meat, fish/seafood, or poultry (Fig. 3). Fish/seafood and poultry dishes provide the most magnesium out of the recipes we have examined.

In Western countries, iron deficiency remains an issue, in particular for women and children (4). However there is no very clear difference in amounts of iron between the meal types we are studying (Fig. 4).

## 5 Discussion

### 5.1 Limitations of our Model

One limitation is inherent to nutrient profiles themselves: they are inexact. Even if a certain nutrient is present in the food, whether and to what extent it will be absorbed when eaten is unknown. This depends on too many variable factors so cannot be calculated. Therefore we cannot know precisely to what extent the nutrients are actually contributing. This creates uncertainty when comparing meal types, but is unavoidable.

Additionally, the goal of this type of study is to gain insights into how we can eat healthier. However, simply looking at recipes is not necessarily representative. First of all, we have a limited number of recipes that we have studied, and these are only from one website. In addition, we have not taken into account how often these pages are visited, and we have no way to know how often a printed recipe is consulted. Epidemiological studies in the field of nutrition must interview participants about what they are eating daily to get a correct idea about their diet. Data analyses such as we performed on recipes can give some ideas but no firm information. In addition, having no way to get recommendations for micronutrients, we could only compare different types of meals. With this information we can give some suggestions, but without conducting an epidemiological study we do not have the information to make conclusions about what would make a good daily diet.

Finally, an issue with our model would be the custom text files made to distinguish meat, fish, seafood, and poultry ingredients. These files are not extensive nor infallible. While we can assert that exception cases are a minority, since they would involve unusual ingredients, so do not unduly influence the results, they most probably do exist.

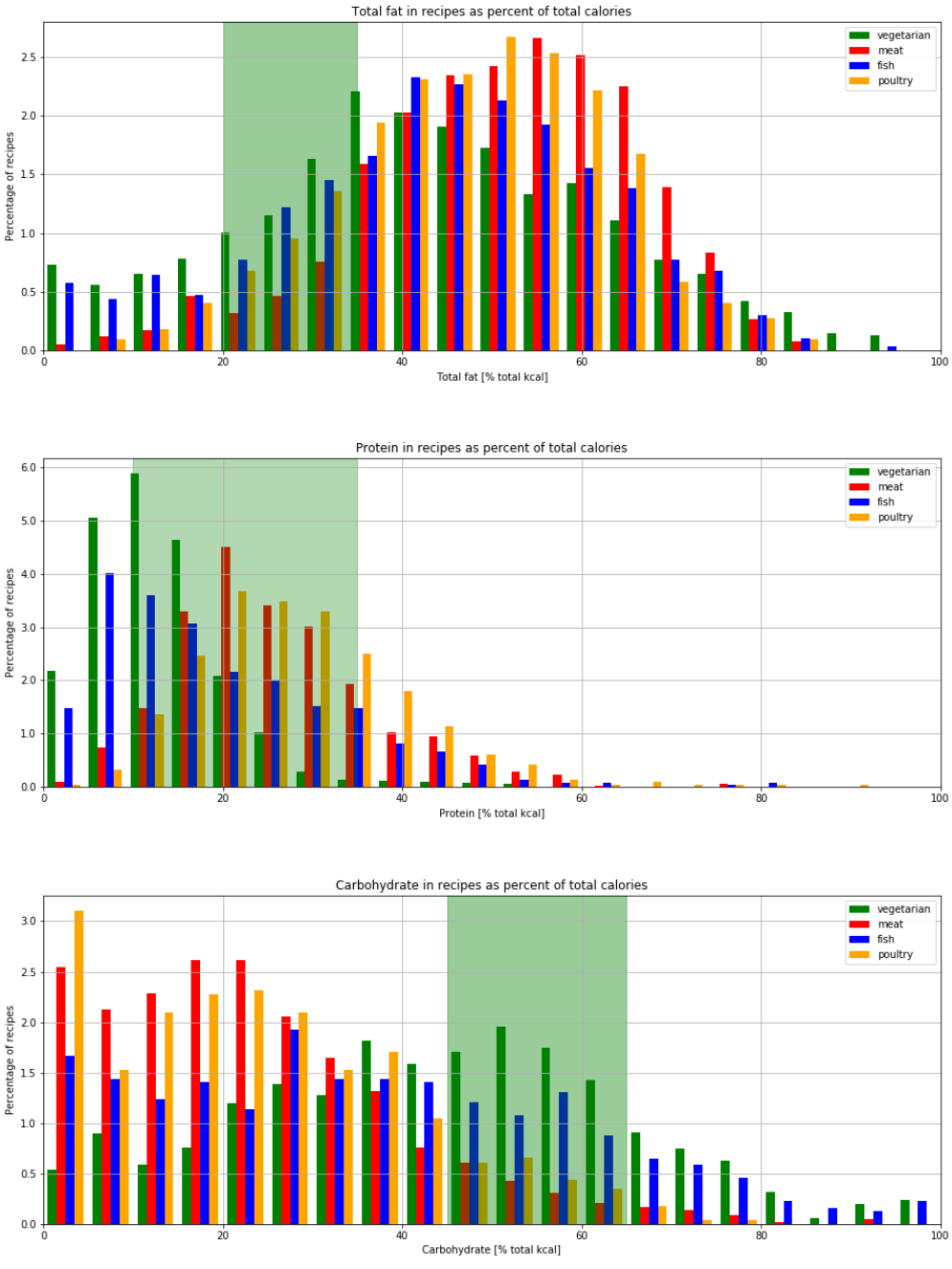


Figure 1: Macronutrients as percentage of total calories. Nutrient distributions are shown for meat, fish/seafood, poultry, and vegetarian dishes. The shaded green area corresponds to the recommended percentage of caloric intake these macronutrients should form.

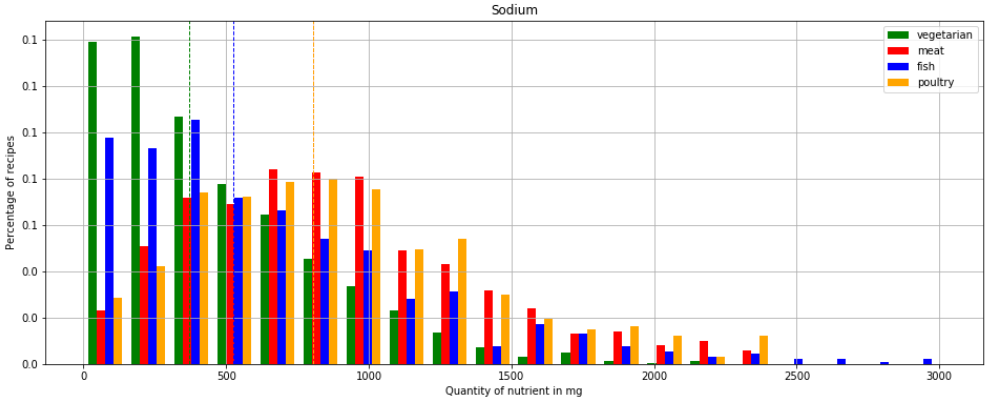


Figure 2: Nutrient distribution for Sodium in micrograms. Shown for meat, fish/seafood, poultry, and vegetarian meal types. The dotted lines show the medians.

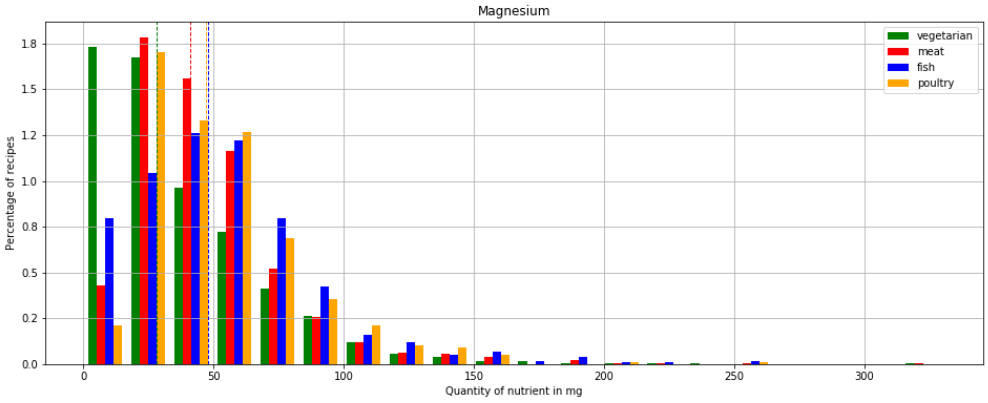


Figure 3: Nutrient distribution for Magnesium in micrograms. Shown for meat, fish/seafood, poultry, and vegetarian meal types. The dotted lines show the medians.

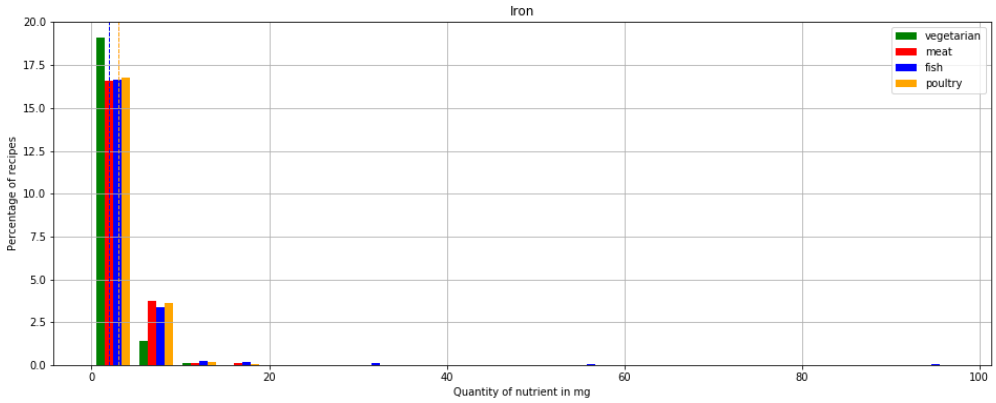


Figure 4: Nutrient distribution for Iron in micrograms. Shown for meat, fish/seafood, poultry, and vegetarian meal types. The dotted lines show the medians.

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