# Using Fibonacci and Phyllotaxis to Advance the Field of Culinary Arts \& Sciences 

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#### Abstract

Scholars have used Fibonacci numbers to solve the mysteries of great works of art, music, and architecture and to understand the natural world. It is quite possible that Fibonacci numbers could be used to enhance our understanding of culinary arts and sciences because they are evident in the fruits, vegetable, and flowers that chefs use to plant, prepare, cook, and serve in foodservice operations every day.


KEYWORDS Fibonacci numbers, culinary arts and sciences, chefs, phyllotaxis

## INTRODUCTION

It would be foolhardy for anyone teaching culinary arts to make the claim that cooking is separate from nature. Indeed, chefs depend on nature's bounty to produce all of the fantastic dishes that have been dreamed up and served since the dawn of time. What we should debate is the means by which we are connected to nature and how that connection manifests itself in the way we plant, harvest, cook, and serve food to others. Is there a natural force at work that is unbeknownst to chefs that compel them to choose certain fruits and vegetables over others and prepare them in ways that are in harmony with nature?

For example, it is said that "people eat with their eyes," and great emphasis is placed on plate presentation. But why is it that some dishes look better than others in the eyes of those passing final judgment, whether it is a restaurant patron or expert panelist at a cooking competition? Is the

[^0]bias a natural one, nurtured over time, or a combination of the two? Perhaps the answer is based on a sequence of so-called living numbers that were discovered centuries ago that have helped scholars in other fields make sense of their disciplines that could bring new insights to those studying culinary arts and sciences.

## THE ORIGIN OF FIBONACCI NUMBERS

Leonardo Pisano was born in 1170 in Pisa (Italy) and was a member of the Bonacci family, which is why he later changed his name to Fibonacci, which translates into "son of Bonacci." He was educated in North Africa where his father, Guilielmo, helped Pisa (then the Republic of Pisa) trade goods with the merchants of Bougie (then Bugia), a Mediterranean port in northeastern Algeria. While in Africa, Fibonacci learned the number systems and arithmetic being used by the Moors. This education led him to later introduce the Hindu-Arabic number system into Europe, which is the system we all learn today based on 10 digits: $0,1,2,3,4,5,6,7,8$, and 9 .

Fibonacci ended his travels around the year 1200 and at that time he returned to Pisa. In 1202 he wrote Liber Abbaci (the book of calculating), which showed that numbers could be added and subtracted easily in addition to describing methods of multiplication and division (Khan, 2006). The Fibonacci sequence arose when Fibonacci, prompted by his father, tried to predict how many rabbits would be produced in a year from a pair surrounded by four walls. Solving this problem led to the resulting Fibonacci sequence of $1,1,2,3,5,8,13,21$, etc. The sequence is a function of adding every number in the sequence to the two numbers that immediately precede it, starting with zero (although 0 is not typically depicted in the equation).

The Fibonacci sequence, in and of itself, does not appear to be very useful until one starts dividing each number by the one before it to produce the following ratios: $1 / 1=1 ; 2 / 1=2 ; 3 / 2=1.5 ; 5 / 3=1.6 ; 8 / 5=1.6$; $13 / 8=1.6$, and ultimately settles upon the value of 1.68 , which is known as golden ratio or phi, as well as the golden mean, divine section, golden cut, golden proportion, divine proportion, and tau $(\mathrm{t})$.

There are also shapes that are derived from the Fibonacci sequence and ratios such as the golden square, which is made using the consecutive numbers of 1,1 . The next is the golden rectangle, which is created by taking two consecutive numbers from the Fibonacci sequence (such as 1, 2) and making the ratio of length to width the golden ratio, which is 1:1.6. A golden triangle is essentially and isosceles triangle drawn such that the ratio of the hypotenuse is equal to the golden ratio (1.6).

Another shape found in nature that is created by the Fibonacci numbers is the golden spiral. Essentially, the spiral shape is obtained by starting with a $1 \times 1$ unit square and then adding golden rectangles according the numbers that follow in the sequence. For example, a golden rectangle of $2 \times 1$ units
would be added to the square, followed by the addition of one that is $3 \times 2$ units, then $5 \times 3$ units, then $8 \times 5$ units. If you draw a line from the first square to the subsequent rectangles that were added, you end up with the golden spiral.

Another shape that can be created using the golden ratio is the pentagram, or star. The pentagram is constructed around one of nature's most appealing shapes-the circle-and then the Fibonacci numbers are used to draw the pentagram. The image of the pentagram in the circle is eerily similar to Da Vinci's famous drawing of the proportions of the male body, which art scholars contend was based on a series of golden rectangles. (Anderson, Frazier, \& Popendorf, 1999)

Indeed, some scholars argue that the reason for the Mona Lisa's timeless appeal is Da Vinci's use of the golden ratio to paint it. The portrait includes many golden rectangles, starting with the face, which fits in a rectangle with a 1:1.6 ratio. If you draw a rectangle from her right wrist to her left elbow and extend the rectangle vertically until it reaches the very top of her head you will find another golden rectangle. There are also golden rectangles that have at their edges the focal points of her chin, eye, nose, and the upturned corner of her infamously shaped mouth.

## PHYLLOTAXIS

According to Ekern (1968), phyllotaxis is derived from the two Greek words that mean leaf (phyllon) and the arrangement (taxis). Those in this field of study have long studied how Fibonacci numbers may explain the growth of buds on trees; the petals on various flowers such as the cosmo, iris, buttercup; as well as the appendages and chambers on many fruits and vegetables such as the lemon, apple, and artichoke (Olimpia, 2008). Fibonacci numbers have been used to study the scales (whorls) on a pine cone, the starfish, the florets on the head of a daisy (Adler, Barab, \& Jean, 1997), and spiral patterns that can be found in every corner of the world of plants (Li, Ji, \& Cao, 2007).

To give an idea of how Fibonacci numbers are used by those who study in this field, consider the number of petals on a sunflower. They are arranged in two sets of two spiral rows, one curving to the left and the other to the right. If there are 34 seed rows that curve clockwise, there will be either 21 or 55 anticlockwise spirals in a sunflower head (Klar, 2002). Other flowers such as the lily and iris have 3 petals, the buttercup and wild rose have 5 petals, the corn marigold and ragwort have 13 petals, the aster and black-eyed Susan have 21 petals, and daisies have 55 (or as many as 89) petals.

As stated by Olimpia (2008), "although exceptions to the Fibonacci rule are not difficult to find, the 'numbers of life' occur so frequently in nature that they cannot be explained by chance . . . there must be a general law of
symmetry, aesthetics and beauty" (p. 607). In effect, the Fibonacci numbers provide astounding evidence for the deep mathematical basis of the natural world, the same world to which culinary arts and sciences has an undeniably strong connection.

## EVIDENCE OF FIBONACCI NUMBERS IN CULINARY ARTS AND SCIENCE

First of all, the hotel sector has already embraced Fibonacci by building a brand based on the numbers and ratios. The Intercontinental Hotel Group launched the Indigo Brand entirely around the Fibonacci numbers, especially the golden mean, because it is inherently pleasing to the mind, according to James Anhunt, senior vice president of brand development. As stated in the first page of its press packet, the design and décor are based on "on timeless beauty found in nature and realized through the Golden Mean" (Hotel Indigo). As such, the geometric ratio of the golden mean has been carried throughout the design of Hotel Indigo from the nautilus shell logo, a timeless symbol of perfect proportion, to the deliberate design of the lobby chairs and guest room furnishings, with the headboards based on golden rectangles. Like snowflakes, the Indigo will also be the first chain where no two properties will look alike.

There is evidence of the Fibonacci numbers in kitchens, regardless of whether the foodservice sector has embraced it or not. Case in point: pick up a banana and examine the number of flat surfaces that comprise its basic shape and then cut it in half to look at the cross section. You would find it has three sides and three seed sections, which are Fibonacci numbers. What about a red delicious apple? You would find a pentagram if you cut it in half at its equator.

Pick up a head of green or purple cabbage and look at the bottom. You will see that the veins of the leaves form the shape of a pentagram. If you look closely at a head of cauliflower you will notice two golden spirals turning in clockwise and counterclockwise directions. If not, visit the following Website: http://www.mcs.surrey.ac.uk/Personal/R.Knott/ Fibonacci/fibnat.html\#veg.

Look around your kitchen to see whether you can find other examples of the Fibonacci numbers in the fruits, vegetables, and flowers used in your kitchen every day. Hint: a star fruit may be the easiest first stop on that tour.

Now turn to something else that occurs in table service foodservice operations every day-plating a meal for a hungry customer. Consider the classic placement of the protein (let's say a pork chop) in the center of the plate with a starch (mashed potato) and vegetable (green beans) placed alongside. What shape might come to mind as your eye moves within the perimeter of the plate from the pork to the green beans to the pile of mashed


FIGURE 1 Symmetrical cheese arrangement.
potatoes and back again? It could be a pentagram or a golden spiral, depending on the diameter of the plate and size and angle of the chop. Perhaps the Fibonacci numbers influenced the choice made by chefs long ago to put protein at the center of the plate accompanied by two sides because it creates an inherently appealing design. Research may one day provide the answer.

Take another common example of a task that is performed by chef's every day-preparing the common cheese tray. For demonstration sake, let $\mathrm{a}=$ cheddar cheese slices (grey) and $\mathrm{b}=$ mozzarella cheese slices (white). Arrange the cheese into symmetrical rows, with two rows per cheese, with the pattern: aa, bb, aa, bb (see Figure 1).

Now lets see what a cheese tray would look like if it were made using the first three numbers of the Fibonacci sequence $(1,1,2)$ going in opposite directions. Again, let $\mathrm{a}=$ cheddar cheese slices (grey) and $\mathrm{b}=$ mozzarella cheese slices (white), with the pattern: aa, b, a, b, a, bb. An eye-catching cheese tray is now depicted in Figure 2, don't you think?


FIGURE 2 Cheese tray arrangement based on Fibonacci sequence.

## FUTURE RESEARCH POTENTIAL

Much like those scholars who have used the Fibonacci numbers to unlock the mysteries of great works of art, architecture, and music, perhaps future graduate students or faculty will become interested in using them to advance our understanding of culinary arts and sciences. It is certainly true that art, architecture, music, and nature's bounty are essential ingredients to any functioning foodservice establishment, but the question is how best to combine them as the Indigo did to perhaps create an inherently appealing dining experience.

As it applies to foodservice establishments, perhaps someone could test the inherent appeal of a restaurant floor plan using the golden rectangle, complete with tables designed on the golden square. Perhaps a study could be designed to test how customers react to a menu card that is based on the golden rectangle that has a variety of courses based on Fibonacci numbers versus a control menu. What if someone were to do a qualitative study to determine whether chefs have a different sense of self when they cook with fruits, vegetables, and flowers that have strong evidence of Fibonacci numbers? Would arranging a fruit platter in the shape of a nautilus be more appealing to people than a fruit bowl?

Perhaps Fibonacci numbers might explain the forces at work at culinary competitions, no matter the level of competition, whether ProStart or American Culinary Federation (ACF). Perhaps someone could design an experiment with ice carvings that had one test and two control carvings. The experimental carving would be based precisely on Fibonacci numbers and the control carvings-although good-would not. The hypothesis would make the prediction that the judges would select the one that was based on Fibonacci and then judges would be brought in to test it and analyze the results. Perhaps a posttest-only design could be employed at the close of a cooking competition to determine whether Fibonacci numbers played a role in a cold platter that took the gold medal compared to those that took silver and bronze.

## CONCLUSION

The Fibonacci sequence has been known to mankind since the early 1200s. It is no doubt an interesting mathematical concept in terms of the sequence itself and the shapes that are created that have an inherent appeal to humans. To that end, perhaps this essay will inspire graduate students or faculty to do research aimed at understanding how the Fibonacci numbers can advance our understanding of culinary arts and sciences, much like those who have used them to advance their understanding of great works of art, architecture, music, and, of course, the natural world. The research potential here is
endless, and perhaps the fruits of one's experimental study will appear one day in the Journal of Culinary Science and Technology.

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## WEBSITES OF INTEREST TO CONCEPTUALIZE RESEARCH PROJECTS

Featured Project-Hotel Indigo: http://designspeaksti.com/featured\ project/ hotelindigo.html
Fibonacci Association: http://www.mscs.dal.ca/Fibonacci/\#art
Fibonacci Numbers in Nature \& Golden Ratio: http://www.world-mysteries.com/ sci_17.htm
The Fibonacci Series: http://library.thinkquest.org/27890/applications6.html
The Golden Ratio and the Fibonacci Numbers: http://www.friesian.com/golden.htm
The Golden Ratio in Art and Architecture: http://jwilson.coe.uga.edu/EMT668/ EMAT6680.2000/Obara/Emat6690/Golden\%20Ratio/golden.html
Golden Spiral: http://en.wikipedia.org/wiki/Golden_spiral
Lahanas, M. The Irrationality of the Pentagon and Pentagram: http://www. mlahanas.de/Greeks/Pentagon.htm
The Life and Numbers of Fibonacci: http://plus.maths.org/content/life-and-numbers-fibonacci

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