Ferreira, Nelson Henrique da Silva

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Evaluating Foodstuff Properties in Antiquity: A Hierarchy of Breads in *De alimentorum Facultatibus I* Proposed by an Ancient Scientist[1]

Nelson Henrique da Silva Ferreira
(University of Barcelona; University of Coimbra)

Abstract

When approaching the nature of things, Galen of Pergamon tends to use an analytic process based on the relation between different elements interacting in a particular system. With respect to ancient eating habits and health, this way of collecting information and formulating hypotheses has some potential for generating hierarchies and is attested to in *De alimentorum facultatibus I*, in which foodstuffs are evaluated considering the particular result expected for a subject's metabolism. This paper aims to describe the manner in which a hierarchical construction is made in respect to the qualities of bread. In order to understand how such a method serves Galen's science, it offers a systematization of his commentaries and notes on different kinds of bread and their nutritional properties in the equation: human body condition + (cereal + type of processing) = body reaction.

Keywords

ancient science; Galen; *De alimentorum facultatibus*; cereals; breads; ancient medicine

1 Despite cereals being crucial for the conception of the categories of breads in *de alim.*, the particularities of cereals touched on by Galen and commented on by other authors (often quoted by Galen in *De alim.)* will not be described or commented on in this paper, for that has already been done in another text to be published in 2019. For a summary of cereal properties in *de alim., vide* tables 1.1, 1.2, 1.3, and 1.4.

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De alimentorum facultatibus is far from being easy reading, whatever one's skill in ancient Greek. Depending on the objects under analysis in his text or the sources quoted by Galen, distinguishing Galen's own opinion on a subject from anecdotes[1] or from opinions of ancient physicians or philosophers known by Galen but not quoted in his speech can be puzzling.[2] Furthermore, there is great intertextuality between Galen's writings, for he tends not to fully restate information already given in previous works – information that would be helpful in clarifying the subject when looking at a single work. In the case of a later text, such as *De alim.*, cross references are abundant, even in a text that resumes and updates previous dispersed considerations on the properties of cereals, both by Galen himself and other authors mentioned by him. For this reason, for those not engaged in philological debates or studies of the Second Sophistic and who would rather extract the maximum contextual and technical information from the text, it may be useful to have a kind of guide while reading it.[3] This paper intends to summarize and offer insights into the technical information concerning the properties of bread, taking into account Galen's own teachings and following his own method of classification: the properties of the foodstuff as markers for defining value.

Grain would have been considered the staple food par excellence and thus it was the focus of ancient authors who studied culture, the technicalities of flora (or agriculture), or healthcare.[4] For example, Cato the Elder specifies the amount of wheat and bread appropriate for good domestic management and, by comparison, relegates all other foodstuffs to a secondary role (cf. Cato 56–58). Vegetius, writing on the supply of the army during a military campaign, says that grain, along with wine and salt, are the provisions whose scarcity should be avoided at all cost (vide Vegetius 3.3).[5] This importance is underlined by the variety of uses for different kinds of cereals, and follows the correlation: production / quantity / consumption / food quality. Accordingly, the products derived from cereal grains were valued according to the type of grain they contained.

It is obvious that grain was crucial for the Mediterranean diet,[6] but the degree to which ancient people knew the benefits or drawbacks of such food is not known. Nutritional science based on a food's metabolic and organic compositions and functions is relatively new and so assumptions cannot be made as to the habits of Romans from today's knowledge of the properties of foodstuffs. However, knowledge about the food ancient people ate (or would have liked to eat) can give us clues about the empirical knowledge of Roman consumers and producers as well as revealing their cultural habits,

1 Vide Mattern (2008: pp. 40–47).

2 See also Singer (1997).

3 On the Second Sophistic vide Mattern (2017) and Whitmarsh (2005).

4 Galen's first approach on grains regarding diet is in *De subtiliante diaeta* (Wilkins 2002: pp. 47–55).

5 Cool (2006: p. 10) presents data collected from an ancient site in Britannia, identifying the production of the most common cereals in antiquity: emmer, spelt and wheat – to which millet should be added.

6 Safrai (1994: pp. 63–68) gives a paradigmatic example of the importance of cereals in macro and micro economic organization in Roman Palestine. Erdkamp (2005: pp. 258–330) notes how crucial grain was in the food supply of the population and in the maintenance of a social system. Vide also Garnsey (1988: pp. 69–86; 182–197; 218–243) on supply and distribution: urban communities.

which in turn may give us some insights into society, economic activity and even the political establishment.[7]

Galen constructs a hierarchy of different types of bread, or rather the qualities that are attributed to each kind of bread, basing it on the quality of the cereals, and the methods of processing and cooking them.[8] It is important to note that Galen's understanding, and that of the wider population of the time respect both the quality and properties of a particular type of cereal would not necessarily concur with the different realities of the various regions of the empire – such knowledge came from assumptions based on tradition and empiricism resulting from observation and experience in specific contexts. In this regard and most importantly, we should note that the considerations made here are based solely on Galen's treaty *De alimentorum facultatibus I* and not on the production process and qualification in antiquity per se, compared to archaeological data or to other ancient authors' notes on diet. I aim to systematize the data provided by *De alim.* in order to understand bread consumption in antiquity from the eyes of Galen but not so much to study the efficiency of production or the technical accuracy of Galen and the previous authors that inspired him, as without Galen's own reference to his predecessors regarding *De alim.* this would be a highly speculative exercise, and difficult to substantiate.[9]

1. Bread in *De alim. fac. I*[10]

1.1. Flour purity and density: considerations for the preparation of bread

Accordingly to Galen, the poorest of wheat-breads are those where flour is made from lower-quality wheat or from flour containing mixed bran (vide table I.1, II). The lower quality is reflected in its nutritional value; however, when the classification 'poor quality' depends on a more porous or loose material, its digestion is easier (cf. *De alim.* 6.481.10.1-482.5). A low nutritional quality means a lower value for the consumer (*De alim.* 6.481.1-10), nonetheless, Galen considers that a loose crumb is easier to digest. Therefore, a bread made from low-quality wheat would not be totally worthless.

For instance, as regards nutritional value, poor cereal is easily digested but there is no way of transforming it into something more nourishing. However, when properly prepared, pure wheat can not only be very wholesome but also easily digestible. The real issue is the density of the material that constitutes the cereal and consequently the flour resulting from it. Galen's approach to "nutrient value" tends to consider that the density

7 Vide Garnsey (1988: pp. 198-217).

8 About the milling process vide Thurmond (2006: pp. 32-51).

9 There are exceptions as Theophrastus, Aristotle or Dioscorides, whose works are known today.

10 The data presented and commented on in this paper is exclusively based on the original Greek. Quotations in English are provided for a better understanding for readers without a knowledge of ancient Greek. Powell's translation (2003) to English of *De alim.* was chosen as it is the most recent. LSJ and GI were the references for considerations on lexicon.

of the grain is directly proportional to the nutritional value and to the amount of work necessary to make the bread and digest it (*De alim.* 6.481.1-5). The work necessary to produce and digest the product has not so much to do with volume, but with the flour's density. The denser the flour is, the more labour required to bake it. An example follows of this and its opposite:

> "But with bran loaves a small amount of leaven, light kneading and a short interval are sufficient. So too, while the pure loaves need a longer period of actual baking, the bran loaves need a shorter one. Between the most pure and the least pure is a wide range where there is more or less purity, some called, and in truth being, pure, and others impure." (*De alim.* 6.482.10-15; transl. Powell 2003).

It is possible to achieve an optimal result, regarding a denser product, through a proportional work of processing it. That is to say, depending on the density of the flour, one would ferment and bake in a way that could improve the volume of the bread, maintaining at same time a good nutritional value. Of course, a limit to this proportionality is implied, although Galen did not identify it. One can assume that in the author's view, a lower density of matter facilitates a faster reaction to heat when baked; therefore, a relation between the characteristics of the flour and the power and uniformity of the heat applied during the baking would have to be found.

Galen identifies a type of bread as the fourth down on his list and therefore the worst, suggesting that the reason for its poor quality is the low nutritional content, together with its digestive effects, although he did not expand on his conclusions concerning the dough of such bread and the process of its preparation. It is the association with the information previously commented on the nutritional value of cereals such as wheat and barley that substantiate the conclusion on the value of bread (vide table 1.1). To quote:

> "Fourth is the group from unwinnowed grain,[11] of which the bran loaf is the worst. It is indeed the least nourishing, and of all breads it moves the bowels most." (*De alim.* 6.484.1-484.5; transl. Powell 2003).

In this passage, it seems that the aversive reaction of the digestive system is due to the very nature of the porous mass that, having little nutritional value, results in faster digestion and, consequently, in lower density and greater dispersion, which favours better excretion. Thus, following Galen's mechanics of associating cause with effect, the author seems to consider that the low density of the mass and its rapid digestion are also related to how excretion is promoted. In short, bread is classified according to its nutritional value and digestive results, and not to a specific recipe. Of course, I'm making this statement considering Galen's assumptions and not modern conceptions and knowledge on chemical properties, nutrition value or metabolic processes.

11 Regarding winnowing in the context of production in ancient Imperial Rome, vide Thurmond (2006: p. 23).

Bread made from pure flour, despite it arguably having a better nutritional quality, requires more care during the preparation process in order to promote better digestion. Comparing types of dough, Galen states that the best bread results from a preparation which aims to reduce the harmful effects of density, while preserving a substantial amount of nutritional matter (cf. *De alim.* 6.482.5-10).[12] The best bread requires waiting for the dough to leaven well in order that it loses its viscous and denser characteristics, since long leavening makes bread easier to digest.

The denser the dough is, the higher is its potential for fermentation, therefore, to rise. In that sense, the bread produced from a pure flour is greater than that of impure flour, as the addition of smaller quantities of yeast will be enough to produce a better rise, for impure flour contains less substance and is already 'bloated' by nature. That is, impure flour is less dense so, the more it rises the less nutrition it would have per volume. Even so, considering Galen's comment on the reasons for making bread from different flours over all, it is clear that the raw material is not the main factor of differentiation. Leavening and preparation time also need to be considered. This is when Galen's theoretical approach omits or ignores that the potential for increasing production from pure flour might also reduce the nutritional quality of bread, since the tendency would be to add more yeast, in order to optimize product quantity and profitability. If the bread is made from a less dense dough, as he says about flour, its nutritional quality will be lower, regardless of the type of baking. Of course, the author is considering preparation of bread in theory and not the actual practice of ancient bakers. For that reason, the artificial addition of yeast in order to boost quantity of the product need not be considered. When compared to other less pure breads, the flour of the best loaves would need to be kneaded more and leavened for longer, which implies higher density of mass, regardless of how much the bread rises during baking. In this case, kneading, leavening and baking must compensate for the fact that this kind of bread disintegrates less easily and is therefore more difficult to digest; nonetheless, its intrinsic nutritional qualities would not have been lost during preparation.[13] In the case of such products, volume is good, for it helps to reduce density, facilitating digestion, while preserving the nutrition of the loaf.

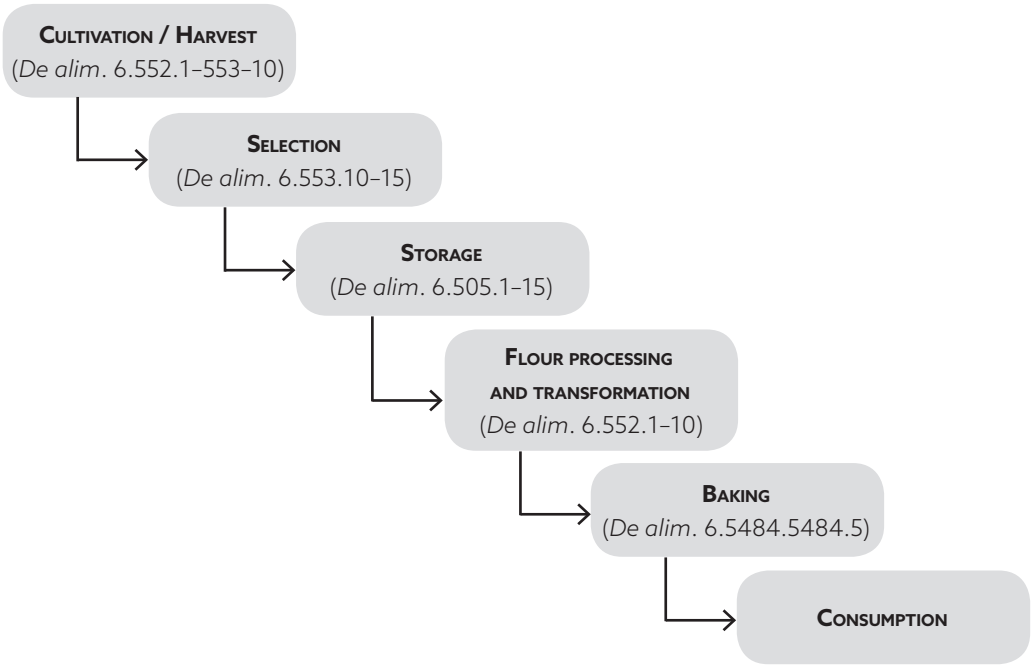
Summarizing, Galen states that the bread made from a type of pure flour is the most nutritious, considering that this bread would always have the best potential properties (vide table III.1 and III.2). The quality of bread depends on the characteristics and species of the grain[14] and on the purpose motivating the baking of the final product, which depends on the result of five basic steps, according to Galen:[15]

12 For iconography relating to the production of bread and other wheat products vide Wilson & Schörle (2009).

13 About dough kneading in ancient Imperial Rome economic/productive context vide Thurmond (2006: pp. 64-72).

14 Vide footnote 2.

15 At this point it must be mentioned that the format of main source text for this paper is not schematic, so the data presented here is reconstructed from Galen's reports and not paraphrased, although the diagrams and tables presented here could suggest otherwise.



2. Types of bread

Galen approaches bread in two ways: theoretically, evaluating a hypothetical product through the conjugation of potential constituent materials; and in reality, based on actual products, such as certain types of bread that would be produced. The designations of the two approaches are separated in tables III and IV as the relationship/distinction between the actual and the speculative product is not always clearly stated.

Breads are hierarchized by Galen according to the purity of the flour in a list of four types of loaves: *silignis*, *semidalis*, a bread of mixed-flour and a scrap bread (cf. *De alim.* 6.483.10-484). There would possibly be issues in the classification of types of loaves and flours due to a widespread lack of manufacturing precision inherent to non-professional production or due to a production not subject to trial. This could justify why Galen tends to comment on 'theoretical' products and not on specific stereotyped recipes. That is, the breads were not always the same in regards to the amount of mixed flours, whereby the variation of the composition of the final product would inevitably be great. It is highly likely, however, that someone experienced in the quality of each product would be able to formulate a recipe for a blend depending on characteristics of the bread required - or at least he would be able to control the process of production in such a way that it may have been possible to always obtain comparable products. This could be the case of loaves made from scraps of different wheat flours or less sieved flours, from which we may infer that it could have contained a substantial amount of bran, considering

Galen's comments (Cf. *De alim.* 6.483.1-10).[16] Considering Galen's commentaries, those products seem to be quite standardized.

However, different mixtures of flours variably altered the qualities of the end-product, since the raw material itself would be different depending on the consistency and quality of wheat, the amount of bran mixed in with the flour and the varying amounts from different harvests.[17] For example, Galen seems to refer to one type of bread, but then considers two different products by naming a loaf in two ways, which would initially correspond to a general concept of mixed flours. The difference may be in the cereals used in the mixture and not on the preparation method or its nutritional value. He names the bread made from various types of wheat as *autopyros*, but later refers to *synkomistos* (Συγκομιστός), a product that seems to be the same as *autopyros*, which literarily translates as 'something mixed together'. One may be looking into a popular generalization regarding the name of the mixture, despite *autopyros* apparently implying a mix of wheat (*pyros*). Such generalizations are also quite common today; therefore a generalized name is not a reference to a specific product made with specific ingredients. It is important to point out that Galen is reporting on eating habits and analysing bread properties. He is not teaching how to make any specific bread, instead, he attempts to gather and present the information available on the subject and then explain its metabolic effects according to the context in which the breads are being consumed.

Since there is not a generalized control over the types of flour nor apparently over the sieving process, the general quality of bread also fluctuates. Despite that, Galen points out clearly that bread made from different grains is better than the last loaf listed in his hierarchy (vide supra; cf. *De alim.* 6.484.1-5). The reason is quite obvious and has to do with purity and cereal quality. Bread made from pure, good cereal is theoretically better than a mixture, which in turn would be better than bread made from 'cereal waste', as the fourth type of bread is suggested to be. Of course, all these assumptions follow Galen's commentaries on cereals, for he takes for granted that bread has a value according to the properties of the cereal that it is comprised of. There is no mention of cereals that once mixed and baked would complement bread's nutritional value.

When Galen is referring precisely to a particular type of bread, whose nutritional and digestive values are suggested as linear and quite invariable, it is probable that he was assuming a similar method of production which would at least standardize certain effects of the product. Even though this information is omitted by the author, one can suppose that in order to standardize the product and to obtain a similar consistent result, an experienced baker would know the amount of a specific type of flour lacking by testing its consistency, colour, and the texture of its dough (cf. *De alim.* 6.494.10-495.1). Galen does not extend his discourse into the details of bread preparation. One cannot

16 For information regarding cereal processing and consumption in Roman world vide Thurmond (2006: pp. 13-72).

17 "But even among themselves which seem to have been set precisely at the mid-point of the range, between the breads derived from bran and those of extreme purity, there is marked variation according to the nature of the wheat. For breads from the compact, heavy wheat are better; those from the loose-grained and lighter wheat are poorer." (*De alim.* 6.483.5-15, transl. Powell 2003).

say for sure if the missing information is due to his lack of knowledge on this subject or if he just considers it unnecessary to talk about it. But, whatever the reason, it is clearly demonstrated that preparation of loaves is fundamental to the hierarchical qualification of such products (cf. *De alim.* 6.484.5-485.5).

Uniformity of the composition and baking point defined good bread. Although the very concept of quality could depend on what the baker was aiming for as there are several factors leading to the production of what could be considered poor-quality bread. The reasons for such a poor product could be reducing the quantities of raw material or preparation time. However, even second-rate bread could be aimed at a 'customer segment' (cf. *De alim.* 6.486.1-5). Starvation or negligence, are not the only justifications for producing and consuming bad quality loaves – even non-leavened breads had their lovers, despite being the worst in regards of digestibility (cf. *De alim.* 6.486.5-10; *De alim.* 6.518.10).[18] This specific type of bread should have been fifth on Galen's list despite him mentioning only four kinds of loaf. The type of flour it was made from is not mentioned. This partial account probably only considers the baking process, believing that the type of flour bears little importance, and for this reason it does not figure in the hierarchy. From Galen's comments one can assume that non-leavened bread would always be more nourishing, independently of the properties of its constituent flour. Thus there are two dimensions for categorizing bread: the type of flour, and its preparation process (that is, leavening and baking).[19]

One thing is certain, this bread 'without or short on leaven' (ἄζυμος) is highly nutritious, inasmuch as it was eaten by athletes – by Galen's accounts, it was the exclusive diet for some gladiators (*De alim.* 6.488.1-15). Galen's accounts can be trusted here as he was quite familiar with the habits of gladiators – he served as a physician of gladiators at the city of Pergamon.[20]

The way the loaves are cooked corresponds to another level of quality although Galen does not present the typology of breads based on baking method. In fact, Galen's classification seems to depend exclusively on flour type and purity. As a matter of fact, cooking methods, when they follow the specific intention of the producer, have many types of consumers, as mentioned above, and depended on the demands for nutritional qualities or taste – as would be understood today (cf. *De alim.* 6.489.5-490.10). The *kribanitai* or loaves made in a *kribanos* are definitely better in general (cf. *De alim.* 6.494.1-10), followed by the loaves cooked in an *ipnos* (cf. *De alim.* 6.489.5). Uniformity of cooking is the rule for the best bread, so the more cooked it is by applying a uniform and constant time and heat, the more proportional would be the properties of the final product (cf. *De alim.* 6.489.5-490.10).

Barley loaves seem to have their own status, as they are not included in the ranking, but are referred to independently. It is not totally clear in the text whether this absence is due to a simple omission or if it implies that Galen's classification of bread lies not

18 About the frequency of food crisis in roman world vide Garnsey (1988: pp. 8-39, 169-181, 271-277).

19 Re the leavening process in the context of bread production in Imperial Rome, vide Thurmond (2006: pp. 59-63).

20 Mattern (2013: pp. 81-98).

with types of cereal. However, that may be unimportant as Galen's interlocutor should already know the comparative properties of cereals due to what he had said about them previously; it is only a question of analogy. Barley breads have the same proportional quality of barley seed when compared to breads made of wheat grain (cf. *De alim.* 6.504.5-504.15; vide tables I.1, I.2, I.3). For that reason I am inclined to think that the type of cereal is not significant in the hierarchy constructed by Galen, and therefore, breads made from different cereals are not directly compared. They are referred to only when there is an exceptional specific characteristic, independently of the purity of the flour.

For example, Galen does not make a detailed distinction between bread made from other cereals than wheat, such as *tife*, *olyra* or *zea*. He did, however, mention *zea* bread by noting Menesitheos' own comment describing such a bread as being stringy, black and sour (*De alim.* 6.514.10-15).[21] Galen's reference to the bread made from *zea*, and to a loaf made by mixing it with wheat (*zeopyros*) contradicts his own account that questioned the existence of *zea* at all (*De alim.* 6.520.5-520.15). He locates the production of this bread in some regions of the Mediterranean (*De alim.* 6.515.5-516.1) thereby, recognizing its existence, or at least a generalized misunderstanding: a grain that could be named in different ways. Considering Theophrastus' comment, quoted by Galen, it is quite difficult to accept a cereal of such bad quality would be consumed (cf. *De alim.* 6.516.1-10), as Galen describes it in the first place, considering the environmental requisites for its production. Theophrastus states that this cereal would need rich soil for its production, which would query a common assumption that the sowing and harvesting of a bad cereal is due to starvation and to the lack of good enough soil and environmental conditions for wheat production. Fertile soils would probably be reserved for more desirable crops such as wheat or barley and not for such an undesirable one. One can suggest two possible causes for this apparent enigma, considering that not much is known about the true properties of these cereals having as parallel wheat and barley, or modern and genetically modified versions due to selection:

a) Galen does not concern himself with the quality of *zea*, leaving that qualification to other authors he quoted. Theophrastus' comment would thus make sense, as he refers to *zea* as a cereal appreciated by animals, and considers it very similar to *olyra* and *tife*, disagreeing with Menesitheos. If this is the case, Galen would just be reporting Theophrastus' assumptions.

b) The amount of zea harvested would be proportionally very high when compared to other cereals. And Galen is accepting Theophrastus' assumption as true, contradicting himself or overlooking the possibility of what is being mentioned as *zea* bread is actually a loaf made from a cereal that is miscalled *zea* – the common confusion in the naming of the cereals *tife*, *olyra* and *zea* mentioned in his treaty.

Despite the apparent imprecision of the text, *zea* is considered to be an ingredient of famine food, due to the bad quality attributed to it (*De alim.* 6.5131-513.10).

21 Dioscorides is the main source quoted by Galen on the cereal *zea* (*De alim.* 6.516.15-517.10; cf. *De materiali medicina* 2.89). Besides *De alim. fac. I* Galen only mentions ζέαν once in his other treaty (*De compositione medicamentorum* 13.257). Vide Wilkins (2005).

The approach to these three cereals is vague. However, Galen did not completely avoid rating them, for he compares *olyra* bread to *tife* bread, considering *olyra* bread better overall, despite paying more attention to *tife* bread (*De alim.* 6.517.15-519.10). This latter, when is fresh, is slightly inferior to wheat, so the same pattern of proportional quality of cereals follows. In fact, Galen takes this analysis further by noticing the slight laxative effect when compared to barley bread, but stating its equivalence to the bread made from millet flour.[22]

Conclusion

Galen's observations are important not only for the study of ancient medicine and culinary history, but also for understanding the productive and economic value of certain goods within social history. Galen would not be the only scholar considering these matters and relating those products with an empirical and generalized consumption, therefore, his assumptions probably reflected a historical reality. Galen's observations would reflect demand, production and cost of breads for the consumer: the variables defining the volume of consumption of each cereal by the general population.

This brief survey has aimed to systematize the information on bread provided by Galen in the first book of *De alimentorum facultatibus*, to make it more accessible to other researchers working in different fields of science, and hopefully bring some light to blind spots in the realm of archaeology. The first volume of *De alim.* is an important source for knowledge on the consumption of and the attitude toward cereal in antiquity, not so much for the encyclopaedic information it can provide, but for the explanation of what seems to be the generalized and traditional knowledge respect on different types of grain in Galen's time. The following tables summarize the information provided by Galen in his treaty.

22 About millet production cf. Cato 1.6.1.

Listed cereals:

Table I.1. The quality of wheat for baking, dense vs. porous: consistency, nutrition and appearance

Mass F (density)	**Nutrition**	**Appearance**	**Mixed bran (Πιτυρίας) – f. proportional**	**Flour purity**	**Volume F (nutrition)**	**Digestive potential**	**Excretory potential**
Dense (*De alim.* 6.481.1; 483.5–15)	Superior (*De alim.* 6.481.1–5; 483.5–15)	Yellower (*De alim.* 6.481.1–10; 522.1–10)	Inferior	Superior	Smaller (*De alim.* 6.481.1–10)	Superior (= all cereals) (*De alim.* 6.520.15–521.5)	Inferior (= all cereals) (*De alim.* 6.520.15–521.5)
Porous (*De alim.* 6.481.1–5; 483.5–15)	Inferior (*De alim.* 6.481.1–5; 483.5–15)	Whitish (*De alim.* 6.481.1–10; 522.10–15)	Superior	Inferior	Scattered	Inferior (= all cereals) (*De alim.* 6.520.15–521.5)	Superior (= all cereals) (*De alim.* 6.520.15–521.5)

Table I.2. The quality of barley for baking: consistency, nutrition and appearance[23]

Mass F (density)	**Nutrition**	**Appearance**	**Mixed bran – f. (Proportional)**	**Flour purity**	**Volume F (Nutrition)**	**Digestive potential**	**Excretory potential**
Dense (*De alim.* 6.504.10–15)	Superior (*De alim.* 6.504.10–15; 6.522.5)	Whitish (*De alim.* 6.522.5; 504.10–506.5)	F = wheat (*De alim.* 6.501.1–503.5)	F = wheat	F = wheat	Superior (= all cereals) (*De alim.* 6.520.15–521.5)	Inferior (= all cereals) (*De alim.* 6.520.15–521.5)
Porous	Inferior (*De alim.* 6.504.10–15)	Yellower (*De alim.* 6.504.10–15)	F = wheat (*De alim.* 6.506.5–15)	F = wheat	F = wheat	Inferior (= all cereals) (*De alim.* 6.520.15–521.5)	Superior (= all cereals) (*De alim.* 6.520.15–521.5)

23 The author notes the superficial evaluation as an unreliable method of verification, when made on the basis of external appearance, weight and colour (cf. *De alim.* 6.481–15).

Table I.3. The quality of tife, olyra and zea for baking: consistency, nutrition and appearance

	Mass F (density)	**Nutrition**	**Appearance**	**Mixed bran – f. (proportional)**	**Flour purity**	**Volume F (nutrition)**	**Digestive potential**	**Excretory potential**
Tife (F = wheat?) (wheatgrass?) (*De alim.* 6.522.1–10; 6.522.10; 520.5–15; 517.15–519.10)	Dense (smaller c / wheat) (*De alim.* 6.522.5)	Superior	Yellower (**reddish** c / wheat) (*De alim.* 6.522.1)	Inferior	Superior	Smaller	Superior (= all cereals) (520.15–521.5)	Inferior (= all cereals) (520.15–521.5)
	Porous (smaller c / wheat) (*De alim.* 6.522.5)	Inferior	Whitish	Superior	Inferior	Scattered	Inferior (= all cereals) (520.15–521.5)	Superior (= all cereals) (520.15–521.5)
Olyra (*De alim.* 6.522.1)	(= *Tife*?)	(= *Tife*?)	White (*De alim.* 6.522.1)	(= *Tife*?)	(= *Tife*?)	(= *Tife*?)	Superior (= all cereals) (520.15–521.5)	Inferior (= all cereals) (520.15–521.5)
	(= *Tife*?)	(= *Tife*?)		(= *Tife*?)	(= *Tife*?)	(= *Tife*?)	Inferior (= all cereals) (520.15–521.5)	Superior (= all cereals) (520.15–521.5)
Zeia (= *Olyra*?) (Hesiod, *De alim.* 6.516.10)	?	?	?	?	?	?	Superior (= all cereals) (520.15–521.5)	Inferior (= all cereals) (520.15–521.5)
	?	?	?	?	?	?	Inferior (= all cereals) (520.15–521.5)	Superior (= all cereals) (520.15–521.5)

Table I.4. Other cereals referred for baking

Millet	It is considered a neutral food for it has a smaller nutritional value and teases little affects on body (*De alim.* 6.523.15–524.5).
Oat	It has a low consumption rate and it is of hard excretion (*De alim.* 6.522.15–523.5).

Table II. Types of flour for baking: general considerations

Cereal	Nutrition: f. Quality (density)	Consumption volume	Terms of use	Regions where they are regularly consumed	Rude quality
Wheat	High (> Barley)	High (= Barley) (*De alim.* 6.504.5–15)	Staple food	All regions of the empire	Generates poor nutritious food of hard digestion
Δ Semolina of wheat (*De alim.* 6.496.5–497.5)	High (< Wheat) (*De alim.* 6.496.5–497.5)				
Barley	High (< Wheat)	High (= Wheat) (*De alim.* 6.510.15–511.1)	Staple food	All regions of the empire	Generates poor nutritious food of hard digestion (> rude Wheat)
Zea[24]	??? < Wheat	< Barley < Wheat (*De alim.* 6.510.15–511.1)	Food shortage (*De alim.* 6.515.15–516.1)	Cold regions (*De alim.* 6.511.1–514.10); Egypt (Herodotus *Historiae* 2.32) (*De alim.* 6.516.10–15)	
Tyfe or *Briza** (Βρίζα) (*De alim.* 6.514.1–10; 6.517.15–519.15)	< Barley < Wheat (*De alim.* 6.510.15–511.1)	< Barley < Wheat (*De alim.* 6.510.15–511.1)	Food shortage instead of wheat sold to the cities (*De alim.* 6.517.1–15)	Regions of Thrace; Macedonia; Asia Minor; Pergamum region (*De alim.* 6.517.15–518.5); Misia (*De alim.* 6.522.5–523.1); Nicaea (*De alim.* 6.515.5–516.1)	
*Olyra**	< Barley < *Olyra* < Wheat (*De alim.* 6.517.1–519.10)	< Barley < Wheat (*De alim.* 6.510.15–511.1)	Food shortage (*De alim.* 6.517.15–518.5)		
Oat	Inferior (*De alim.* 6.522.5–523.5) (for animals?)	< *Zeia*, *Tife*, *Olyra* < Barley < Wheat (*De alim.* 6.522.5–523.5)	Food shortage (*De alim.* 6.522.5–523.5)	Asia Minor; Misia (*De alim.* 6.522.5–523.5)	

24 * Menesitheos' commentaries (*De alim.* 6.512.5–513.10) quoted by Galen were not considered for the analysis of these cereals.

Table III.1. Types of bread listed (properties by comparison): Hypothetical

Categories of breads and cakes	**Flour**	**Processing (W_p = F. (d))**	**Leavening (F. (density))**	**Baking**	**Excretory potential**	**Digestion / distribution (a priori)**	**Nutritional level (a priori)**	**Product quantity / nutritional value**
'Pure bread' (ideal case)	Dense wheat flour, highly refined? (*De alim.* 6.482.5–10)	Greater work (*De alim.* 6.482.5–10)	Inferior (*De alim.* 6.482.10–15)	Inferior (*De alim.* 6.482.10–15)	Inferior (*De alim.* 6.482.5–10)	Inferior (*De alim.* 6.482.5–10)	Superior (*De alim.* 6.482.5–10)	Superior (*De alim.* 6.482.5–10)
Light bread (*De alim.* 6.494.10–495.1)	Sparsely (*De alim.* 6.494.10–495.1)				Lightly exciting (*De alim.* 6.494.10–495.1)	Superior (*De alim.* 6.494.10–495.1)	Inferior (*De alim.* 6.494.10–495.1)	Inferior (*De alim.* 6.494.10–495.1)

Table III.2. Types of bread listed (properties by comparison)

Categories of breads and cakes	**Flour**	**Processing (W_p = F. (d))**	**Leavening (F. (density))**	**Baking**	**Excretory potential**	**Digestion / distribution (a priori)**	**Nutritional level (a priori)**	**Product quantity / nutritional value**
***Silignis* ('Fresh bread'; σίλιγνις)** (*De alim.* 6.483.10–484.5)	Dense highly refined wheat flour	Greater work	Superior		Inferior	Inferior	Superior	Superior
***Semidalis* (σεμίδαλις)** (*De alim.* 6.483.10–484.5)	Dense refined wheat flour (slightly lower than *silignis?*)	Greater work (slightly lower than *silignis*)	Superior (slightly lower than *silignis*)		Inferior (slightly lower than *silignis*)	Inferior (< *silignis*)	Superior (< *silignis*) (*De alim.* 6.496.5–497.5)	Superior (< *silignis*)
Artos piturias Ἄρτος πιτυρίας ('bran loaf')	Flour from wheat bran (*De alim.* 6.481.10–482.5)	Inferior (*De alim.* 6.481.10–482.5)	Inferior (*De alim.* 6.483.10–15; *De alim.* 6.481.10–482.5)		Exciting (*De alim.* 6.481.10–482.5)	Superior (*De alim.* 6.481.10–482.5)	Inferior (*De alim.* 6.481.10–482.5)	Inferior (*De alim.* 6.481.10–482.5)
4° bread (*tífinos*?) (*De alim.* 6.504.5; *De alim.* 6.483.10–484.5)	Generated from the lower quality grain. Negligent sieve?				Exciting	Inferior < bran-loaf	Little nutritional level (the worst of the loaves) (*De alim.* 6.484.1–5)	Inferior (?)
Autopyros Αὐτόπυρος **or? Συγκομιστός (bread from mixtures?)**	Various types of flour and sieved (*De alim.* 6.483.5–15)	Median, however, variable (*De alim.* 6.483.5–15)						

Table III.3. Breads mentioned – out of the hierarchical list[25]

Categories of breads and cakes	Processing (W_P = F. (d))	Leavening (F. (density))	Excretory potential	Digestion / distribution (a priori)	Nutritional level (a priori)	Product quantity / nutritional value
Tífinos (*De alim.* 6.504.5–504.15)			Exciting	Hard		
'Unleavened' bread (ἄζυμος) (*De alim.* 6.488.1–15)	?	ø	?	Very hard	High	?
Raw bread	?	ø	?	Very hard	High	?
Barley bread (*De alim.* 6.501.1–503.5)	= Cereal	= Cereal	= Cereal	= Cereal	= Cereal	= Cereal

Table IV. Barley breads vs. Wheat bread

	Barley breads (*De alim.* 6.506.5–506.15)	Wheat bread (*De alim.* 6.506.5–506.15)
Nutrition	–	+
Easier to digest	+	–
	Porous barley loaves (*De alim.* 6.506.5–506.15)	Bran-loaf (*De alim.* 6.506.5–506.15)
Nutrition	=	=
Easier to digest	+	–

25 'Breeze bread' was ignored because it is mentioned only circumstantially in quotation from Menesitheos (cf. *De alim.* 6.514.10–15; 515.5–516.1).

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Nelson Henrique da Silva Ferreira / nelsonhenriquecechuc@gmail.com

Centre of Classical and Humanistic Studies
University of Coimbra, Faculty of Arts and Humanities
Largo da Porta Férrea, 3004-530 Coimbra, Portugal