This file contains all reviewer reports in order by version, followed by all author rebuttals in order by version.

nature portfolio

Peer Review File

Periodic cooking of eggs

Corresponding Author: Professor Ernesto Di Maio

Version 0:

Reviewer comments:

Reviewer #1

(Remarks to the Author)

The paper you're reviewing discusses an innovative approach to cooking eggs, addressing the inherent challenge posed by the need to cook the egg's two main components—the albumen (white) and the yolk—at different temperatures. The key discovery shared in the paper is a technique that allows for the simultaneous cooking of both the albumen and yolk at their ideal temperatures without the need for separation. This is accomplished by applying periodic boundary conditions within the context of the energy transport problem, a method likely involving controlled heat application that varies over time or space in a way that matches the specific thermal requirements of each component.

Overall is an interesting approach but it lacks considerations about its real impact and/or application.

Form safety point of view raises several questions to avoid microbiological issues, such as salmonella. This is not addressed. Is thermal load sufficient to avoid microbiological issues ?

REgarding sentence “In so doing, it was found that, to our taste, the optimal thermal profile inside the egg is obtained by imposing a temperature…” This sentence is unclear. Has sensorial analysis been performed? This should be done to validate if this method determines good organoleptic outcomes.

The outcomes achieved may drastically change depending on the size of the egg. The authors should provide an estimation that takes this factor into account. This is not clear through the manuscript.

From a practical perspective, the cooking process could take ten times longer than other cooking methods. Figure 2 illustrates that the cooking index is only significant when compared to hard-boiled eggs. The difference between the proposed method and other methods (such as soft boiling or sous vide) appears negligible and will likely be influenced or dissipated by factors that are difficult to control in real-world scenarios.

For all these reasons, I do not recommend paper acceptance in its presence form. More expermental evidences should be incorporated to justify the importance of this approach

Reviewer #2

(Remarks to the Author)
The theme of the article is relevant to several areas such as nutrition, gastronomy and engineering.
The article reported an innovative technique for cooking eggs in a practical way, obtaining sensory characteristics desired by chefs.
However, some points need to be clarified:
- Explain the variation in the amount of lipids after cooking for four different cooking techniques.
- One of the justifications for the research was to obtain eggs with albumen and yolk with the same creamy texture. Why wasn't texture analysis and sensory testing carried out?
These issues need to be clarified before the article is published.

Reviewer #3

(Remarks to the Author)
1. To emphasize the innovative nature of this work, it is crucial to provide additional information in the background section regarding the practical implications of cooking eggs through the cold-hot cycling method in egg processing.

2. In fact, the egg white and egg yolk within an egg constitute a heterogeneous system, with significant differences in their composition and notable variations in their thermal denaturation processes. Simple heat transfer models cannot accurately reflect the actual thermal denaturation process of eggs.
3. The cooking process of eggs is greatly influenced by the variety and quality of the eggs themselves. Whether the Th and Tc values designed in your proposed method have general significance for egg processing is worth further exploration.
4. How to determine the maturity standards for egg white and egg yolk, and what are the corresponding inspection indicators?
5. To further elucidate the structural changes during the aggregation process of eggs, it is recommended to perform fitting and qualitative analysis of the FT-IR results to assess the alterations in β-sheet structures.

Version 1:

Reviewer comments:

Reviewer #1

(Remarks to the Author)
Revised version has improved the overall quality of the manuscript and addressed the previous reviewer's queries. However, the quality of the figures needs improvement; for instance, Figure 2 contains a lot of information that is difficult to read. The manuscript can be accepted for publication with minor revisions.

Reviewer #2

(Remarks to the Author)
Dear editor,

I would like to thank you for the opportunity to review the article titled "Periodic cooking: the perfect egg". It was a pleasure to contribute to the enhancement of this work.

After a careful review of the revisions made by the authors, I have prepared the attached technical review, in which I recommend the publication of the article in Communications Engineering.

Please feel free to contact me if you require any further clarification. After reviewing the corrections submitted by the authors in response to the comments raised during the initial review, I find that all suggestions have been satisfactorily addressed. The main modifications include:

Clarity and Cohesion: The authors revised the structure of the text, improving the clarity and cohesion of the content. Sections that required better organization have been adjusted, making it easier for the reader to understand.

Methodology: The methodological explanations have been detailed as requested, providing a more complete and rigorous description of the procedures adopted. This enhances the replicability of the study.

Discussion of Results: The authors expanded the discussion of the results, incorporating suggestions for additional literature. The critical analysis has been enriched, providing a more comprehensive and well-founded view of the study's implications.

In view of the above, I consider that the article, in its revised version, meets the scientific and editorial requirements necessary for publication. The proposed modifications have significantly improved the quality of the work, making it suitable for sharing with the scientific community.

Therefore, I recommend the publication of the article in Communications Engineering.

Sincerely,
Sabrina Carvalho Bastos.

Dipartimento
di Ingegneria Chimica,
dei Materiali e della
Produzione Industriale
Università degli Studi
di Napoli Federico II

Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale
Università degli Studi di Napoli Federico II
P.le Tecchio 80
80125 Napoli, Italia
Phone: +39 347-3668799
E-mail: edimaio@unina.it
URL: http://www.dicmapi.unina.it/

July 30, 2024

Dr. Rosamund Daw
Chief Editor, Communications Engineering
4 Crinan Street London N1 9XW, UKy

Dear Reviewers,

Thank you for taking time to assess our manuscript. We read your comments carefully and tried to address all the concerns you have raised in the revised manuscript. Each and every comment will be specifically addressed in the following.

Response to Reviewer 1

REV: The paper you're reviewing discusses an innovative approach to cooking eggs, addressing the inherent challenge posed by the need to cook the egg's two main components—the albumen (white) and the yolk—at different temperatures. The key discovery shared in the paper is a technique that allows for the simultaneous cooking of both the albumen and yolk at their ideal temperatures without the need for separation. This is accomplished by applying periodic boundary conditions within the context of the energy transport problem, a method likely involving controlled heat application that varies over time or space in a way that matches the specific thermal requirements of each component. Overall is an interesting approach but it lacks considerations about its real impact and/or application.

AU: We hope that the revised version of the manuscript is able to assess all raised concerns and to clarify the actual impact of this work (see Lines 94-97, 104-105, 128-130, 139-140, 144-149 of the Main Text).

REV: Form safety point of view raises several questions to avoid microbiological issues, such as salmonella. This is not addressed. Is thermal load sufficient to avoid microbiological issues ?

AU: It is widely known that eggs are a dangerous vehicle for pathogen transmission, like Salmonella. To assess this issue, we deepened our knowledge of pasteurization (the conventional thermal process used to inactivate pathogenic microorganisms) and studied whether or not periodic cooking is adequate to reduce the salmonella count to an insignificant level. In order to do this, data derived from a careful literature review were exploited, revealing complete safety of the periodic cooking method. See lines 90-92 of the Main Text and Subsection 2.2 of the Supplementary Text

for more extensive comments on the subject.

REV: Regarding sentence "In so doing, it was found that, to our taste, the optimal thermal profile inside the egg is obtained by imposing a temperature…" This sentence is unclear. Has sensorial analysis been performed? This should be done to validate if this method determines good organoleptic outcomes.

AU: For a deeper understanding of the organoleptic outcome of periodic cooking with respect to the other proposed cooking methods, we performed Sensory Analysis. Data on texture and taste were collected and interpreted, revealing the effectiveness of periodic cooking in delivering two different textures and tastes in the egg albumen and yolk. Results and full interpretation can be found in lines 93-100, Figure 2b,2c of the Main Text and Subsections 1.2.6, 2.4 and Tables 4,5,6 of the Supplementary Text.

REV: The outcomes achieved may drastically change depending on the size of the egg. The authors should provide an estimation that takes this factor into account. This is not clear through the manuscript.

AU: We added a comment that clarifies that the simulation and the study in general can be adapted to the size of the egg by simply changing the scaling arguments already introduced in the paper(See lines 80-84 of the Main Text). In particular, for an estimation of the changes in the results, it is key to take into account the characteristic time for heat transport (L^2/a): the length of the cold and hot cycles scale with the square of L, characteristic dimension of the object.

REV: From a practical perspective, the cooking process could take ten times longer than other cooking methods. Figure 2 illustrates that the cooking index is only significant when compared to hard-boiled eggs. The difference between the proposed method and other methods (such as soft boiling or sous vide) appears negligible and will likely be influenced or dissipated by factors that are difficult to control in real-world scenarios.

AU: We recognized that the Cooking index evaluated through IR spectroscopy is only slightly different in all cooking methods except for hard-boiling. As a consequence, we decided to highlight further differences expanding the research through Sensory Analysis, Texture Profile Analysis and Metabolomic Analysis. Results of these studies proved that the Periodic cooking method not only has advantages in terms of both texture and taste, but it also gives the reachest sample in terms nutrients, especially polyfenols. This justifies the ten times longer cooking time.

REV: For all these reasons, I do not recommend paper acceptance in its presence form. More

expermental evidences should be incorporated to justify the importance of this approach

AU: We hope that the revised version of this manuscript is able to deliver the potentiality and all the advantages of this novel egg cooking method.

Response to Reviewer 2

REV: The theme of the article is relevant to several areas such as nutrition, gastronomy and engineering. The article reported an innovative technique for cooking eggs in a practical way, obtaining sensory characteristics desired by chefs. However, some points need to be clarified: - Explain the variation in the amount of lipids after cooking for four different cooking techniques.

AU: The hypothesis for the lipid amount variation in the different cooking techniques is that there is an exchange in nutrients between the egg white and the egg yolk as the cooking proceeds (See lines 319-330 Supplementary Text). Further validation of this hypothesis is considered outside of the scope of the present contribution.

REV: - One of the justifications for the research was to obtain eggs with albumen and yolk with the same creamy texture. Why wasn't texture analysis and sensory testing carried out?

AU: Sensory Analysis and Texture Profile Analysis are both present in the revised version of the manuscript (See lines 93-100, Figure 2b,c of the Main Text and Subsections 1.2.6, 2.4 and Tables 4,5,6 of the Supplementary Text for the Sensory Analysis. See line 93 and Figure 2g of the Main Text and Subsections 1.2.5, 2.5 and Tables 3, 8 of the Supplementary Text for the Texture Analysis). Results of these studies confirm expectations deriving from the simulation results.

REV: These issues need to be clarified before the article is published.

AU: We hope that the revised version of the manuscript is clearer with respect to the previous one and that we were able to solve and explain all the raised issues.

Response to Reviewer 3

REV: 1. To emphasize the innovative nature of this work, it is crucial to provide additional information in the background section regarding the practical implications of cooking eggs through the cold-hot cycling method in egg processing.

AU: Pratical implications of cooking eggs through cold-hot cycling were scattered through the text (See lines 41-43, 76-77, 94-97, 104-106, 128-130, 145-147 of the Main Text). These comments can

be mostly found in the results and conclusions section because we were not able to find examples of a cooking method similar to ours in the literature and we were only able to derive the practical implications following the simulation and, most importantly, the characterization of the egg.

REV: 2. In fact, the egg white and egg yolk within an egg constitute a heterogeneous system, with significant differences in their composition and notable variations in their thermal denaturation processes. Simple heat transfer models cannot accurately reflect the actual thermal denaturation process of eggs.

AU: To take into account the denaturation process of eggs, we coupled a conduction only heat transfer model with the gelation equation (see lines 44-51, 65-66 of the Main Text and lines 39-44 of the Supplementary Text). In the revised version of the manuscritp we also added a comment to underline the fact that we used two different set of parameters for the yolk and the albumen, respectively, to be able to take into account the heterogeneous nature of the system at hand (see lines 44-45 of the Supplementary Text).

REV: 3. The cooking process of eggs is greatly influenced by the variety and quality of the eggs themselves. Whether the Th and Tc values designed in your proposed method have general significance for egg processing is worth further exploration.

AU: We added a comment that clarifies that the simulation, and the study in general, can be adapted to the quality of the egg by simply changing the thermal and kinetic properties in the simulation (See lines 80-84 of the Main Text), provided that these data are available in the literature, or can be derived from a preliminary ad hoc research.

REV: 4. How to determine the maturity standards for egg white and egg yolk, and what are the corresponding inspection indicators?

AU: A variety of inspection indicators is present in this work, them being introduced with Sensory, Spectroscopic, Metabolomic and Texture Profile Analysis (see Figure 2, Main Text). According to the specific predetermined goal (level of denaturation, amount of nutrients, wetness of the yolk, etc.), one can define the maturity standard of egg yolk and albumen.

REV: 5. To further elucidate the structural changes during the aggregation process of eggs, it is recommended to perform fitting and qualitative analysis of the FT-IR results to assess the alterations in β-sheet structures.

AU: We have analyzed the amide region (*aggregation band*) with the scope of identifying a Cooking

Index which would quantitatively compare the degree of cooking with respect to a reference. To fully process the alterations of the β-sheet structure upon cooking (which is substantial) would require a systematic experimental approach with further ad-hoc experiments, which is beyond the scope of the present contribution.

Sincerely,

Ernesto Di Maio

Dipartimento
di Ingegneria Chimica,
dei Materiali e della
Produzione Industriale
Università degli Studi
di Napoli Federico II

Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale
Università degli Studi di Napoli Federico II
P.le Tecchio 80
80125 Napoli, Italia
Phone: +39 347-3668799
E-mail: edimaio@unina.it
URL: http://www.dicmapi.unina.it/

November 12, 2024

Dr. Rosamund Daw
Chief Editor, Communications Engineering
4 Crinan Street London N1 9XW, UKy

Dear Editor and Reviewers,

Thank you for taking time to assess our manuscript. We read your comments carefully and addressed all the concerns you have raised in the revised manuscript. Each and every comment will be specifically commented in the following. Changes in the amended manuscript are not highlighted in colors because they are mainly related with the structure of the manuscript (which was massively reviewed according to editorial requests), while the content stayed the same.

Response to Editor

ED: Your manuscript titled "Periodic cooking: the perfect egg" has now been seen by two of our original referees, whose comments appear below. In light of their advice I am delighted to say that we are happy, in principle, to publish a suitably revised version in Communications Engineering. We therefore invite you to revise your paper one last time to address the remaining concerns of our reviewers. At the same time we ask that you edit your manuscript to comply with our journal policies and formatting style in order to maximise the accessibility and therefore the impact of your work.

AU: Thank you for your decision to potentially publish a revised version of our manuscript in Communications Engineering. We hope that we were able to assess all raised concerns and requests in our revision work.

ED: A couple of editorial points also to consider: In the main text, you mention: Additionally, mass spectrometry (MS) analysis revealed that, specifically in the yolk, the periodic cooked eggs result in the highest polyphenol content (Figure 2e). What exactly are we meant to look at in Figure 2e that shows this result? The plot is not clear in explaining this. I believe that the nutritional impact claims and data are valuable, and so I would recommend that the discussion of nutritional impact in the SI section 2.6 and any relevant data is elevated to the main text rather than burying in the Supp Info.

AU: In order to assess the raised concern, we added an additional comment when describing the

content of previous Figure 2e (current Figure 6) with the scope of making it more clear. Moreover, we elevated the discussion of nutritional impact to the main text, as suggested (see current paragraph H-NMR and UHPLC Q-Orbitrap HRMS based analyses in Results and Discussion).

ED: The manuscript is actually much shorter than the Supplementary Information document. We note that you only have two figures in your main manuscript and 18 figures in your Supplementary Information file. Therefore I would suggest that you consider elevating other text and data from the SI section to make the most of the space available in your manuscript and make it easier for readers to follow the story. (Referring back to Supp Info can make reading a paper a more fragmented experience.) For example perhaps the simulations data and supporting text (removing any repetition with Figure 1)? (Figures SI 2,3, 4,5)

AU: In accordance with the suggestions made, we revised the whole structure of the manuscript, elevating many paragraphs of the previous Supplementary Information to the main text. More specifically, we now have in the main text: an Introduction, a Results and Discussion section (with Cooking Simulations, FT-IR spectroscopy, Quantitative Descriptive Analysis, Texture Profile Analysis and H-NMR and UHPLC Q-Orbitrap HRMS based analyses, with the corresponding graphs and figures), a Conclusions section, and a Materials and Methods section (with Materials, Egg cooking methods, Mathematical modeling and simulation, and Characterization techniques paragraphs). We left the remaining sections in the Supplementary Information, but we find that we now have a much better balance between main and supplementary text.

ED: * Your manuscript should comply with our policies and format requirements, detailed in our style and formatting guide (https://www.nature.com/documents/commsj-phys-style-formatting-guide-accept.pdf).
Please edit your manuscript according to the editorial requests in the attached table, and outline revisions made in the right hand column. If you have any questions or concerns about any of our requests, please do not hesitate to contact me. It is important that each request be addressed in order to avoid delays in accepting your manuscript. Please upload the completed table with your manuscript files.
Please refer to our checklist for a full list of the files that must be provided upon resubmission: https://www.nature.com/documents/commsj-file-checklist.pdf Please ensure a completed version of this file is uploaded as a Related Manuscript with your final submission. (The file checklist is also provided at the end of the editorial requests table)

AU: We carefully read the editorial checklist and made sure to address all of the requests.

ED: * An updated editorial policy checklist that verifies compliance with all required editorial policies must be completed and uploaded with the revised manuscript. All points on the policy checklist must be addressed; if needed, please revise your manuscript in response to these points. Please note that this form is a dynamic 'smart pdf' and must therefore be downloaded and completed in Adobe Reader. Clicking this link will download a zip file containing the pdf.
Editorial policy checklist: https://www.nature.com/documents/nr-editorial-policy-checklist.zip

AU: The updated editorial policy checklist has been completed. We hope that we were able to re-format the manuscript in the most appropriate way.

Response to Reviewer 1

REV: Revised version has improved the overall quality of the manuscript and addressed the previous reviewer's queries. However, the quality of the figures needs improvement; for instance, Figure 2 contains a lot of information that is difficult to read. The manuscript can be accepted for publication with minor revisions.

AU: As a response to the raised concern, we decided to split previous Figure 2 in more Figures of hopefully higher quality. We now have, in spite of Figure 2, the following: current Figure 3, Figure 4, Figure 5 and Figure 6. We also modified the main text of the manuscript accordingly, elevating a lot of the information previously reported in the Supplementary Information to the main text (as also requested from the editorial board). We hope that the novel version of the manuscript is able to deliver all the messages in a more complete way and, most importantly, with figures of a higher quality.

Response to Reviewer 2

REV: I would like to thank you for the opportunity to review the article titled "Periodic cooking: the perfect egg". It was a pleasure to contribute to the enhancement of this work. After a careful review of the revisions made by the authors, I have prepared the attached technical review, in which I recommend the publication of the article in Communications Engineering. Please feel free to contact me if you require any further clarification. After reviewing the corrections submitted by the authors in response to the comments raised during the initial review, I find that all suggestions have been satisfactorily addressed.

AU: Thank you for your kind words, we are happy that we could improve the quality of our manuscript in such an efficient way.

REV: The main modifications include:
Clarity and Cohesion: The authors revised the structure of the text, improving the clarity and cohesion of the content. Sections that required better organization have been adjusted, making it easier for the reader to understand.
Methodology: The methodological explanations have been detailed as requested, providing a more complete and rigorous description of the procedures adopted. This enhances the replicability of the study.
Discussion of Results: The authors expanded the discussion of the results, incorporating suggestions for additional literature. The critical analysis has been enriched, providing a more comprehensive and well-founded view of the study's implications.
In view of the above, I consider that the article, in its revised version, meets the scientific and editorial requirements necessary for publication. The proposed modifications have significantly improved the quality of the work, making it suitable for sharing with the scientific community.
Therefore, I recommend the publication of the article in Communications Engineering.

AU: As a response to the reviewer's comments, we did not change the content of our manuscript, as it is apparently very efficient in delivering all of the messages that we wanted to communicate. Nevertheless, to respond to specific editorial request, we changed the form of the manuscript, which is now divided into more sections and subsections and contains some of the informations previously contained in the Supplementary Information. We hope that the re-formatting of the article did not change its effectiveness in communicating the results and the methodologies with the reader.

Sincerely,

Ernesto Di Maio