**Reviewer #1:** The manuscript presents new experimental data on how charring impact grain morphology and stable isotopic values of cereal grain. It builds on previous experimental work by examining a greater range of temperature and its effects on grain morphology, isotopic values and offsets concerning bread wheat, hulled barley, rye and oat. The methodology of the experiment is carefully designed and performed, and the results presented are discussed and integrated with previous isotopic experimental research. Then, the authors provide guidelines to follow when selecting samples for isotopic analysis. From the criteria provided in this paper, but also because stable isotope analysis is frequently used in archaeological research, I can see the study presented in the submitted MS to be both important and useful to researcher wanting to conduct isotopic analysis on grains of these cereal species.  
  
The data and methods used in this study presents original research interpretations; the study is scientifically suitable to JAS and I recommend publication. Given that the study/MS is well written, clear and well structured, I have only minor comments.  
  
  
Line 18/26, 52/53, 63, figure/table texts, etc. Which wheat, barley species? If bread wheat and hulled barley, I think it should be specified, not just by genus, and this should be consistent in the MS.

*I have clarified the species throughout the MS.* I have also added full Latin names in the methods section.  
  
  
Line 36/39 In line 36, the MS mentions "Two papers published in 2015…" Then at the end of the sentence makes only reference to Charles et al. 2015. My guess is that also Nitsch et al. 2015 should be mentioned here.

*Yes it should have been! I have corrected that.*   
  
Line 387-296 Variability in growing conditions could of course affect some outcomes/results of the experimental data, but difficult to get around completely I think. Good that this issue is discussed in section 3.5, and suggestions provided for accommodating this.  
  
  
Line 575 and line 602, References: Fernandéz-Crespo et al. 2020, and Larsson et al. 2019 are listed in the reference list, but do not appear in the MS text.

*The paragraph they were references for had been remove in an earlier draft – I have now removed them from the reference list*  
  
  
**Reviewer #2:** This is a very thorough experimental investigation of the effects of charring on cereal grains, extending the range of species and temperatures beyond those previously investigated. This is particularly important for later periods of history when new cereal crops became widespread. For the most part the paper is clearly written though minor improvements could be made to some of the descriptions of statistical analyses and the presentation of results. Useful recommendations are made for correction factors to be applied to archaeological charred grains to bring them into line with per-charring isotopic ratios, and practical suggestions are made for the selection charred archaeological grains suitable for isotopic analysis, in both cases backed up by the experimental evidence.  
  
I was surprised, however, that, although emphasis was placed on the importance of charring species (such as oat and rye) not previously investigated through experimental charring, the recommended correction factors were the same for all species, even though rye and particularly oat, responded differently to charring, notably in relation to nitrogen isotopic values. I would like to see some justification for this decision in the text.

*See below for added justification*

The following minor changes are recommended to clarify aspects of the statistical analysis and presentation:  
  
Physical changes:  
  
Line 200: Are there differences in grain density that might also affect the degree of distortion?

*It is possible that differences in grain density might also affect the distortion. However it is not something this experiment explored.*   
  
Table 2: the 'box' for barley at 230°C for 24 hours (score of 4) should be a darker shade of brown.

*Corrected*  
  
Isotope results:  
  
Lines 225-6: The description of the plots in Figure 3 (also applies to Figure 4) could be better (more accurately/clearly) described. The charred grains' δ13C values are not plotted "against" the average of the uncharred replicates (values for both charred and uncharred grains are plotted on the same (vertical) axis); it would be more correct to say, "the δ13C values were plotted in comparison to the uncharred replicates". And what is plotted is not the actual δ13C value for each replicate but rather the deviation from the mean value of the uncharred replicates. This may well be properly described in Nitsch et al. 2015 (referred to in lines 157-8) but even so it would worth explaining here to assist the reader in the interpretation of the plots. Similarly in the caption, it would be helpful to say that the horizontal line at 0.0 represents the mean of the uncharred replicates and the values on the vertical axis the deviation from this mean.

*I have changed the line to say “Comparing the deviation of charred grains’ δ13C values from the uncharred replicates average δ13C values shows this variability especially in the rye and oat (Figure 3)”.*

*The caption now reads: “Figure 3. The deviation δ13C values of barley, bread wheat (BW), oat and rye for the different times and temperature combinations from the mean δ13C value of uncharred replicates. Horizontal line represents the mean for the uncharred replicates.”*  
  
Line 237: "significant" at what level of probability? Add (p<0.05) after the word 'significant'? [the level of probability used is finally mentioned (for δ15N) in line 281 but should be introduced earlier.]

*Corrected by added p<0.05*  
  
A couple of the descriptions of "trends" observed in Figure 4 do not seem to accurately reflect what is shown in the plots:  
  
Lines 262-3: I could see no downward "trend" in oat "subsequent to" 215°C but rather values for ALL temperatures from 230°C to 300°C tend to be lower than those at 215°C and, if anything, those at 260°C and 300°C tend to be higher than the intermediate temperatures. It is noticeable, however, that all values for charred grains are higher than the mean for uncharred grains, which might be worth mentioning at this point.

*I have changed the sentence to read:*

*“Oat samples show an initial increase in δ15N value from uncharred to 215°C, the largest difference from the uncharred mean, while the 230°C - 245°C temperature batches subsequently decrease from that high, with the mean δ13C values plateauing for the 260°C – 300°C batches.”*

Lines 264-5: While it is clear that "there tends to be a trend of increasing δ15N values as temperature increases" for wheat, I could see no clear "trend" for barley (as implied by the previous sentence which refers to both taxa), for which only the values at 300°C tend to be relatively high.

*I have clarified that statement replacing it with:*

*“Hulled Barley and Bread wheat δ15N value variabilities differ, being less variable than rye and oat. Bread wheat shows a trend of increasing δ15N values as temperature increases, resulting in the higher temperatures having the largest difference from the uncharred material, corroborating a similar observation by Nitsch et al. (2015).”*

Tables 3 and 4 (5 and 6): Some justification is needed for presenting the results of statistical analyses for all four taxa together when some trends in isotopic values (particularly δ15N) appear to be in opposite directions.

*I have inserted a paragraph explaining our reasoning behind conducting a grouped offset instead of a single species offset. See lines 310 to 322 which reads:*

*Previous research has noted that variations in the biochemical compositional of grains could potentially result in different species or even landraces reacting to charring conditions in different ways (Nitsch et al. 2015). Moreover, modern charring experiments only recreate a subset of the potential combinations of temperature and duration that are relevant to preservation by charring. As in Nitsch et al’s (2015) work, the approach taken in the present study was not to attempt calculation of individual species’ charring offsets, for which a larger number of observations per species would be needed. Rather, the present study aimed to capture the range of variations observed across the four species examined, providing an indicative offset applicable to all of the species. Full data are published in Stroud et al (data-in-brief-submission), including all data from Nitsch et al. (2015). This dataset provides a basis for charring offsets that could be in future tailored to particular crops suites, or to explore single species differences, but these further steps are outside the scope of this paper.*

Isotope offsets:  
  
Lines 309-10: The 'slightly increased fit' of LM2 compared to LM1 (when using all charring temperatures) can't be seen in Table 5 where the R2 is the same for both models (at 2 decimal places). Perhaps reword to say that the increase in fit is negligible.

*Corrected, now reads:*

*The addition of the charring coefficient to the model (LM2) results in a negligible increase in the fit of the model (see Table 5) and the p-value for charred-fresh is not significant.*  
Lines 310-311: This is slightly confusing because Table 5 also shows LM1 using different temperature ranges.

*I have clarified within text that table 5 shows both LM2 and LM1 values (line 341 to 348)*  
  
Lines 316-317: Strictly speaking the similarity of δ13C values for uncharred batches and those charred at 215°C explains why there is NO significant difference when the 215°C batch is INcluded (rather than the significant result when this batch is excluded).

*I have moved that statement up to the section talking about no significant differences between the uncharred- charred 215-260/300 batches.* Line 349

Lines 317-318: "A 0.16‰ offset is recommended if the temperature range is restricted to 230-300°C." It's not clear on what basis this recommendation is made - what are the grounds for recommending a 0.16‰ offset? Is this measured by the Beta value? If so, a connection needs to be made between 'Beta' and 'offset' earlier in the text for those not familiar with this terminology. The paragraph in lines 287-294 would seem a good place to do this, and also perhaps add 'offset' in brackets after 'Beta' in Tables 5 and 6, or add this to the figure caption (more important than "rounded to 2 decimal places" which is obvious). The abbreviation 'CI' for confidence interval may also not be obvious to everyone.

*I have added the clarifying sentence of:*

*“The 230-300°C model predicts that there is a 0.16‰ difference between the δ13C value of the charred material compared to the uncharred material shown as the beta coefficient, falling within a 95% conference interval (CI) of -0.03 to -0.29‰ (Table 5).” Line 355-358*

*I have also added in a new line when beta values are first mentioned say line 249:*

*“The effect that temperature has on the δ13C value is limited, with the greatest impact in the 215-260°C and 215-300°C analysis* *Using the beta coefficient (the mean change between the outcome variable – δ13C – for every unit of change of the predator variable – time or temperature) it can be calculated that there is a 0.05‰ change for every 15°C, resulting in a 0.14‰ difference between 215°C and 260°C, and a difference of 0.26‰ between 215°C and 300°C.”*

*I did not place this within the line 287-294 section as suggested as that is talking about nitrogen when carbon introduces it first. I however do not want to put beta=offset in, because in the sections 3.2 and 3.3 beta is not used as an “offset”– as those models are looking at time and temperature in just the charred material. The beta coefficient is a common value from regression models and I feel that this now should be explained sufficiently.*

Line 320: "…which they described as "moderately significant". This gives the impression that Nitsch et al. made a subjective judgement - might it be better to say something along the lines of "- though neither value is significant at the 0.05 level, both are very close to this"

*Done – I have changed to:**Restricting the temperature range to 230-260°C results in p-value between charred and uncharred of 0.06, a similar result to Nitsch et al. (2015) model’s p-value of 0.057 and while neither of those values are significant at the 0.05 level, both are very close to it.*

Lines 322-324: I suggest "the confidence interval…does include zero" rather than "the confidence intervals…do cross zero".

*Corrected as suggested*  
  
Lines 324-326: A table showing the offsets for each species would illustrate this.

*The Nitsch et al offsets are mentioned in table 1.*  
  
The comments above refer to the carbon offset section; similar issues apply to parts of the nitrogen isotope section.

*Done.*

In addition to this:  
  
Lines 345-346: "When all temperature batches are included (215-300°C), the offset is 0.33‰ with a 95% CI between -0.62 to -0.02‰ (see Table 6)." The statistics cited here (for δ15N) are different to those cited for similar analyses of δ13C values, with no reason given for why the boundaries of the confidence interval are highlighted for nitrogen isotopes but not carbon isotopes. Also, should this sentence end as follows: "…with a 95% CI between -0.64 and -0.02‰ (see Table 6)" [-0.64 rather than -0.62 - to be consistent with Table 6]?

*I have added the CI values in the carbon sections – and made the table/text consistent*  
  
Lines 360-361: "…the 300°C samples tend to have δ15N values similar to the uncharred material" This is true but (as mentioned in the one of the comments above) oat is a notable exception.

*I have changed the sentence to:*

*The 215°C samples from some of the taxa have δ15N values which differ greatly from the uncharred material, while the 300°C samples some of the taxa tend to have lower deviation in charred grains δ15N values compared to uncharred material’s values (see Figure 4).*  
  
Lines 364-366: "the analysis of charred material only does indicate that charring temperature impacts δ15N values with the model indicating a -0.31‰ difference between specimens charred at 215°C and those charred at 300°C". I don't think this evidence is presented in a table? Perhaps this should be noted.

*This information is noted within text in section 3.3 line 296. It is not in a table but can be calculated from the beta values in table 4.*

Lines 366-367: "This is due to the large difference in the δ15N value of the 215°C batches of rye and oat, compared to the uncharred material". If this really is an analysis of charred material ONLY, then the difference between charred and uncharred material can have no effect on the result. It presumably means that this difference in δ15N between samples charred at high and low temperatures for oat and rye (visible in Figure 4) was masked in the previous analyses, where comparisons WERE made between 'charred' and uncharred samples.

*I have clarified this section as I can see I was not very clear. See lines 404 to 420*  
Variability:  
  
Lines 404-405: Reporting on results from Nitsch et al. 2015 "a 95% CI of ±0.5 for δ13C and ± ~1‰ for δ15N would account for the variability within a single growing condition." Why are these values expressed differently for the two isotopes - is there something missing here, e.g. '‰' after '0.5' for δ13C? [reading on this seems to be the case]

*Yes it is missing a ‰- I have added it in.*

Conclusions:  
  
Lines 536-538: "Between 230°C and 300°C, the isotopic offsets for wheat, barley, rye and oat are 0.32‰  
(δ15N, 95% confidence interval -0.62, -0.02) and 0.16 ‰ (δ13C, 95% confidence interval -  
0.29, -0.03)." Minus signs should appear on the same line as the number following the sign [as in -0.29] in the pdf/published version of the paper.

*I have changed this so hopefully the minus sign does not become an orphan.*