

# Bake your phantom - low-cost recipes for dough-based, tissue-mimicking CT phantoms

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## MOTIVATION

- CT phantoms have various applications e.g. experimental research, test data generation or educational purposes [1]
- Currently available:
 

Ready-to use phantoms	3D printing / synthetic materials
+ Very realistic	+ Individual
- Expensive	- Expensive equipment
- Lack of modification	- Time-consuming
- Our novel approach: Doughs → Cheap, simple & fast creation

## METHOD

Analysis of different mixtures:

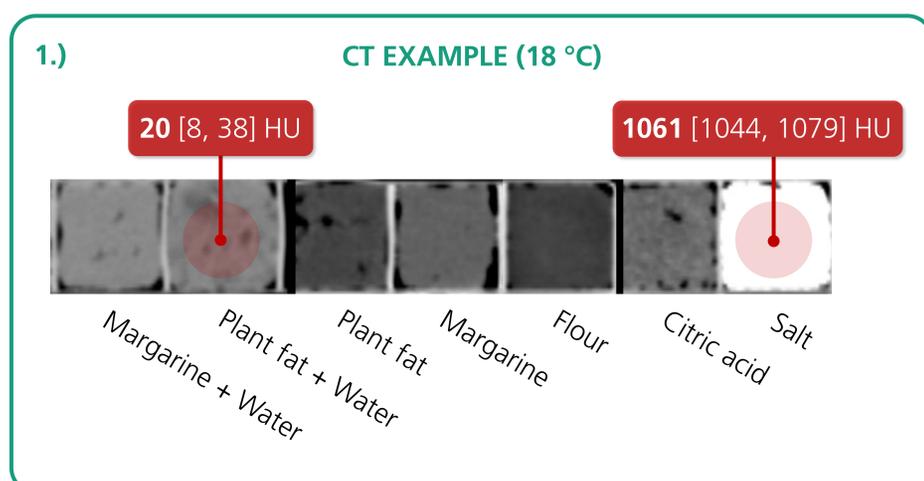
- 90% flour + 10% citric acid + water
- 100-x% flour + x% salt + water,  $x \in \{10, 20, \dots, 100\}$
- Flour + margarine, flour + plant fat
- Dry ingredients: Flour, salt, plant fat, margarine and citric acid



## EVALUATION

- Creation of small samples and filling into an ice cube mold
- Acquisition of CT images at 18 °C, 6 °C and -18 °C
- Evaluation of each sample in the CT scan with the median, 25% and 75% quantile of the Hounsfield units (HU) → see box 1.)
- Recipe generation by combination with human tissues intensities [2] → see box 2.)
- Liver phantom creation: 3D printing of a liver mold and filling with the most suitable dough for a liver [3] → see box 3.)

## RESULTS



## REFERENCES

- [1] Wegner M., Gargioni E., Krause D. Classification of phantoms for medical imaging. Procedia CIRP 2023; 119:1140–1145.
- [2] Chougule V, Mulay A, Ahuja B (2018) Clinical case study: spine modeling for minimum invasive spine surgeries (miss) using rapid prototyping. Proc COPEN 226:3071
- [3] Alshoabi SA., Alharbi RM., Alghohani RB. et al. Grading of fatty liver based on computed tomography Hounsfield unit values versus ultrasonography grading. Gastroenterol Insights 2024; 15:588–598.

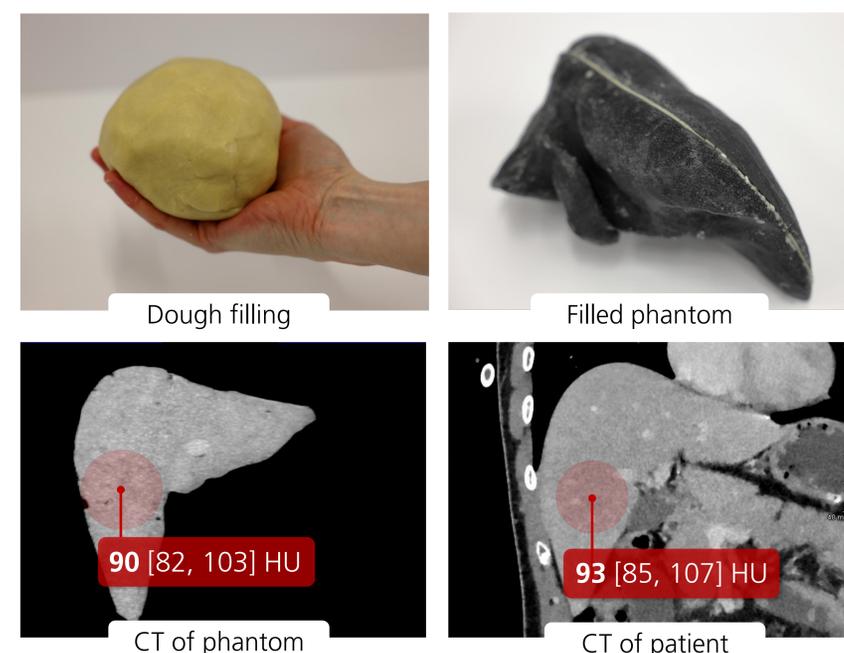
## OBSERVATIONS

- HU intensity: salt increases the intensities, whereas fat decreases them
- Structure: thorough mixing is important to have a homogeneous structure; small air inclusions could be observed
- Temperature: salt causes high HU differences, lower differences observed for plant fat and margarine

## 2.) RECIPES

Human tissue	HU ranges	Median HU at			Recipe ingredients
		18 °C	6 °C	-18 °C	
Enamel	[1553,2850]	---	1616	1629	100% salt
Compact Bone	[662,1988]	727-1061	822-1616	773-1629	24-40g salt, 16-0g flour, 13-0g water
Spongy Bone	[148, 661]	180-636	191-657	158-659	0-20g salt, 36-20g flour, 20.6-13g water, 4g citric acid (if no salt)
Muscle tissue	[-5, 135]	68	71	84	40g flour + 25g margarine
		20	19	27	40g flour + 40g plant fat
Fat tissue	[-205, -51]	-92	-88	-61	100% margarine
		-187	-194	-177	100% plant fat
Skin tissue	[-718, -177]	-207	-204	-202	100% flour

## 3.) LIVER PHANTOM



## CONCLUSION

- Novel CT phantom method
- Recipes for different human tissues
- Next steps & future work:
  - Further recipe refinement
  - Development for specific applications

## Paper



[s.fhg.de/PhantomPaper](https://s.fhg.de/PhantomPaper)

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