Comparing fractal algorithms to evaluate meat quality based on MRI and data mining

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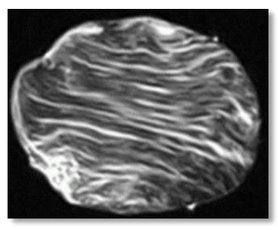
ABSTRACT

Traditionally, quality characteristics of meat products have been estimated by means of physico-chemical analysis. Computer vision algorithms on MRI joined to data mining techniques have been presented as an alternative to these destructive methods, since, MRI is non-destructive, non-ionizing and innocuous. In recent years, there is a growing interest in the use of fractal techniques instead of classical texture analysis methods. The fractal concept studies the degree of symmetry of self-similarity found in a structure at all scales. However, the use of fractal algorithms to analyze MRI has not been mainly used for this purpose. In this study, two fractal algorithms have been compared and tested: Fractal Texture Algorithm (FTA) and One Point Fractal Algorithm (OPFTA). OPFTA has a computational complexity of O (n^2), which is slightly lower than that of FTA (O(n^2 * log (n))). Regarding to prediction of quality parameters of meat products, OPFTA and FTA reached correlation coefficients higher than 0.75 with OPFTA being better (R > 0.82). These results seem to indicate the use of OPFTA to analyze MRI from meat products in order to characterize this food in a non-destructive, effective and accurate way.

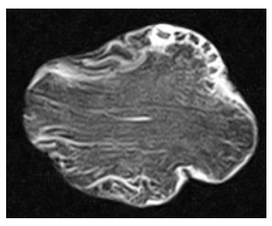
OBJECTIVES

The main objective of this study is to compare and to test two fractal algorithms (FTA and OPFTA) in terms of i) computational complexity and ii) accuracy for prediction some physico-chemical parameters of meat products in order to analyze in a non-destructive, effective and accurate way.

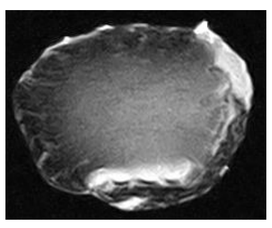
MATERIAL AND METHODS



HIGH LEVEL LIPID CONTENT



MEDIUM LEVEL LIPID CONTENT



LOW LEVEL LIPID CONTENT

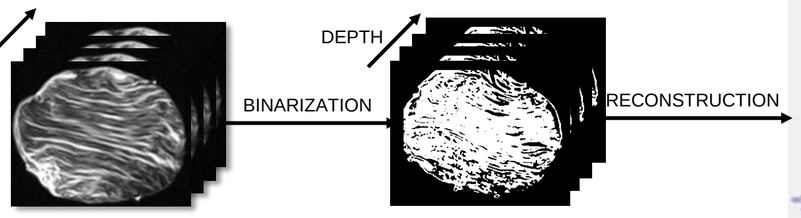
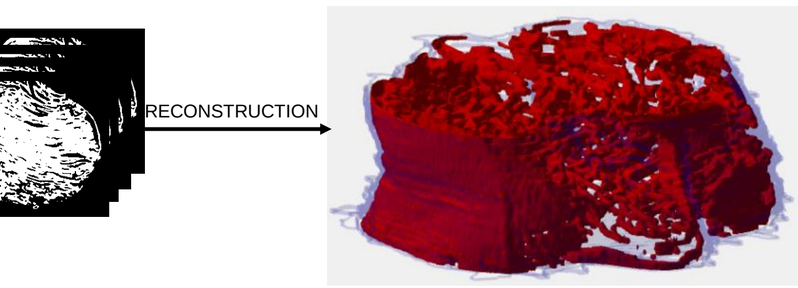


IMAGE ACQUISITION

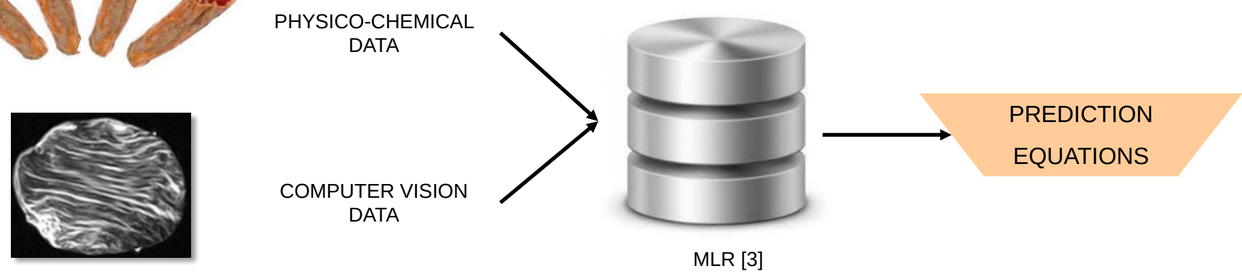
- ESAOTE VET-MR E-SCAN XQ 0.18 T
- HAND/WRIST COIL.
- SPIN ECHO WEIGHTED ON T1
- FIELD OF VIEW: 150 x 150 mm²
- SLICE THICKNESS: 4 mm
- MATRIX SIZE: 256 x 204
- SLICES PER ACQUISITION: 29.
- NUMBER OF IMAGES: 5220
- 9 COMBINATIONS OF TE AND TR.



FRACTAL ALGORITHMS

- FRACTAL TEXTURE ALGORITHM (FTA) [1]
- ONE POINT FRACTAL TEXTURE ALGORITHM (OPFTA) [2]

PREDICTION ANALYSIS



RESULTS AND DISCUSSION

Table 1. Computational complexity of two studied fractal algorithms.

ALGORITHMS	COMPUTATIONAL COST
FTA	O (n^2 * log (n))
OPFTA	**O (n^2)**

Table 2. Correlation coefficient (R) of the prediction equations for physico-chemical parameters of dry-cured loins.

PHYSICO-CHEMICAL TRAIT	FTA	OPFTA
MOISTURE (%)	0,832	**0,951**
WATER ACTIVITY	0,828	**0,954**
SALT CONTENT (%)	0,795	**0,956**
LIPID CONTENT (%)	0,835	**0,837**
COLOR L*	0,765	**0,826**
COLOR a*	0,765	**0,854**
COLOR b*	0,756	**0,823**

Table 3. Prediction equations for physico-chemical parameters of dry-cured loins obtained with OPFTA.

PHYSICO-CHEMICAL TRAIT	EQUATIONS
MOISTURE (%)	= 49.57 * UNI + 64.84 * ENT + 4.68 * COR + 16.97 * HOM + 55.77 * INE – 30.92 * CON + 42.81 * EFI - 25.96
WATER ACTIVITY	= 0.37 * UNI + 0.33 * ENT + 0.02 * COR + 0.03 HOM + 0.16 * INE – 0.14 * CON + 0.15 * EFI + 0.57
SALT CONTENT (%)	= - 8.90 * UNI – 7.55 * ENT – 0.51 * COR – 0.27 * HOM – 3.66 * INE + 3.28 * CON – 3.22 * EFI + 9.31
LIPID CONTENT (%)	= - 15.62 * ENT – 7.47 * HOM - 13.20 * INE – 22.42 * EFI + 36.19
COLOR L*	= 14.89 * ENT + 18.90 * HOM + 31.62 * INE – 29.37 * CON + 19.37 * EFI + 26.54
COLOR a*	= - 2.95 * HOM – 7.32 * INE + 7.49 * CON – 6.86 * EFI + 15.58
COLOR b*	= 12.88 * UNI + 3.21 * ENT – 4.71 * HOM – 6.59 * INE – 7.73 * EFI + 5.64

CONCLUSIONS

These studies show that i) FTA and OPFTA are appropriate algorithms to analyze MRI from meat products in order to determine quality characteristics in a non-destructive way, ii) OPFTA is better than FTA in terms of computational cost and accuracy of prediction. These results seem to indicate the use of OPFTA to analyze MRI from meat products in order to characterize this food in a non-destructive, effective and accurate way.

REFERENCES

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