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Research Article

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Effect of Textural Properties on Prawn Chips Using Image Processing Technique

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ABSTRACT

The aim of proposed study was to analyze the effect of textural changes on prawn chips using image analysis at various processing levels such as frying, drying and storage of the chips after 15 days. Formulations were optimized with flour combinations of 45 % wheat and 25 % refined wheat flour (Maida) and 30 % prawn flour. Drying at 60^{0}C in an oven dryer, followed by the frying of prawn chips at 140^{0}C, led to moisture removal. This shows that, the varied intensity of brown colour in the products varies with stages of processing, which had strong impact on the prawn chips. Surface texture analysis was done by converting the digital image to grey scale, using Grey level co-occurrence matrix method. The changes in intensity of the grey levels can be reduced for a feature reduction, which was considered to be a parameter of importance. It was also used as predictive tool for determining the moisture based on the grey levels. Results of moisture content, oil uptake and shrinkage after frying were 5.3%, 2.1%, and 16.2 % respectively. The study proposed that application of the image processing could be a rapid method for monitoring the food products.

Key words: Prawn, Frying, Colour Intensity, GLCM, Image analysis

Introduction

Prawns are the good source of proteins when compare to other sea foods like crab, fish which has low fat content and calories, even though it has high cholesterol content shrimp muscle has more poly unsaturated fatty acid (PUFA) which needed for our body [1]. Protein from prawns was found to be have similar results when compared to fish or meat based on protein efficiency ratio and biological value which means shrimps can be used as substitute studied in [2]. Utilization of prawns in the food industry has been increased mainly due to its protein content used in food products such as soup mixes [3] , Ready to eat (RTE) products such as chips, biscuits , crackers which attracts future generations were studied in [4] [5]

Image processing is a non-destructive technique used in wide range of operations which can be performed using digital image as an input to convert into grey scale image. Based on grey level intensities within image features can be studied [6]. Image analysis technique is used for quick way of identification of acryl amide formation in potato chips during frying or post manufacturing [7] .Texture property is the major parameter which changes using various unit operations such as frying and Drying .Most widely used techniques of image by Gray level co-occurrence matrix (GLCM) to extract the features based on image texture [8]. Some changes like staling can be happened during storage of breads can be progressed under GLCM using image analysis technique was studied by [9]. Among conventional drying methods freeze drying has less effect on the product surface properties which involves sublimation of porous product with high quality. Freeze dried banana and potato were studied under instrumentation analysis and computer vision technique using image analysis were investigated in [10,11]

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The purpose of this research was to examine the texture changes of the prepared prawn chips using image processing technique and extraction of features by GLCM which enables to observe their various texture characteristics change of the chips during different stages of unit operation and storage.

Materials and Methods

Pre treatment of samples

Pre-processing techniques of prawns were carried out with cleaning followed by treating the prawns with antimicrobial agents which was then subjected to heat treatment at 50^0C, The boiled prawns were dried and size reduced by ball mill which was studied and reported by [5]

Ingredient & process optimization

The optimization of the flour mixture was done by trial method. Major ingredient constitutes of Wheat flour (40-60%) and Refined wheat flour (Maida) varies from (20-40%) and prawn composition (30-70%). Minor ingredients containing seasoning mix of 5% (w/w) were added which constitutes of dried chilli, cumin, Asafoetida, thyme, black pepper and bay leaf powder, which can improve aroma and can naturally mask the meaty-note from prawn. Additionally, salt of 3% (w/w) was added to optimize major ingredient. 100 gram of mix was added to improve taste and serves as a natural preservative in the final product.

Dough preparation was followed by sheeting into even thickness of 2mm, then drying to remove moisture content by hot air oven at 60^0C for 3 minutes and frying of chips at 140^0C for about 30 seconds. Seasoning mix was dusted on the surface of chips. The prepared chips were packed and stored at ambient condition (37^0C) [5]

Grey-Level Co-occurrence Matrix of prawn chips

The samples were placed inside a black box at a distance of 19.80 cm from the position of camera for analyzing the features derived from G.L.C.M method. Based on the level of importance only five are considered for chips. The features such as Contrast, Homogeneity, Dissimilarity, Energy, and Entropy were finalized based on mean and variance of the samples. The conversions of color image to grey scale were calculated using M.A.T.L.A.B [12]. Studies were revealed that deviation in the values may occur not only with the displacement but also the orientation of adjacent pixels of the chips samples. This can be effectively determined using the Grey-Level Co-occurrence Matrix (G.L.C.M). The samples were 200 x 200px in size for the calculations primarily horizontal orientation in this study.

$$Homogeneity = \Sigma_{i,j}^{n} \frac{1}{1(i\text{-}j)}\, p(i,j) \quad (1)$$

$$Dissimilarity = \Sigma_{i,j}^{n} \mid i - j \mid p(i,j) \quad (2)$$

$$Contrast = \Sigma_{i,j}^{n} \mid i - j \mid^2 p(i,j) \quad (3)$$

$$Entropy = \Sigma_{i,j}^{n} p(i,j) \log (p(i\text{-}j)) \quad (4)$$

$$Energy = \Sigma_{i'j}^{n} p(i,j)^2 \quad (5)$$

$$Variance = \frac{[|\text{m-1}|+|\text{m-2}|+|\text{m-3}|+|\text{m-4}|]}{4} \quad (6)$$

pd, θ(i, j) denotes the number of count in neighbouring pair pixels with gray intensity values of i and j at a certain distance of d and a given direction of θ respectively.

Results and Discussion

Preliminary trials

Based on preliminary studies, the flour composition of wheat and maida were 45% and 25% respectively. with the substitution of 30% of prawn flour were finalized based on the overall acceptability of 7.51 and desirability values of 0.871, respectively, which were finalized and studied by [5] and the prepared chips have interaction of moisture content of 5.3%, oil uptake of 2.1 % and shrinkage of chips after frying were found to be 16.2 % were reported in [13][14]

Image analysis of prawn chips

Image analysis was done based on colour intensites of the chips which underwent non-enzymatic browning (Maillard reaction), with interaction of ingredients when subjected to frying. Colour parameter is the primary important attributes for quality. Extraction of features was done by conversion of colour image to grey scale. For features extraction from the digital images, algorithms were developed using software Matrix Laboratory (MATLAB).

The following samples were analysed for image analysis which was shown in Table 1

Table 1. Sample codes and conditions

S no	Image codes	Conditions
1	Image 1 - Dried chips	Temperature of 60^{0}C for 5 min
2	Image 2 – Fried chips	Temperature of 140^{0}C for 30 seconds
3	Image 3 – Overburnt chips	Temperature of 140^{0}C for 45 seconds
4	Image 4 – Stored chips	Temperature of 37^{0}C for 15 days

Fig. 1. Dried chips

Fig. 2. Fried chips

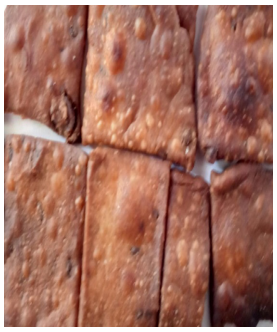

Fig. 3. Overburnt chips

Fig. 4. Stored chips

Fig. 5. Colour image to Grey scale image conversion using MATLAB

Table 2. Extracted Features for four different images

Features	Image1	Image2	Image3	Image4	Mean	Variance
Dissimilarity	0.1344	0.0789	0.0689	0.0788	0.09025	0.1663
Sum average	6.6845	7.4708	6.5139	7.6153	7.071125	0.0025
Sum variance	28.7097	38.2074	28.4962	39.3445	33.68945	0.0005
Auto Co-relation	19.7784	23.6336	19.5609	24.1558	21.782175	0.0075
Contrast	0.1352	0.0792	0.0689	0.0789	0.09055	0.0005
Correlation matrix	0.9999	1	1	1	0.999975	0.0075
Correlation pap	-1.2778	-1.2917	-1.2735	-1.2947	-1.284425	0.0025
Cluster prominence	1.49E+07	17335000	14489000	17795000	1.61E+07	12403.51
Cluster shade	-2.40E+05	-268170	-234300	-273570	-2.54E+05	14127.31
Energy	0.2391	0.2315	0.2111	0.2488	0.232625	0.0025
Entropy	-0.2078	-0.2032	-0.1874	-0.2159	-0.203575	0.0225
Homogeneity	0.9329	0.9606	0.9656	0.9606	0.954925	0.0023
Maximum probability	0.3575	0.3639	0.2981	0.3944	0.353475	0.075
Sum of square variance	19.7109	23.5181	19.4661	24.0486	21.685925	0.0026

(Table continued)

(Table continued)

Sum entropy	1.6932	1.6972	1.7436	1.69	1.706	0
Difference variance	0.1352	0.0792	0.0689	0.0789	0.09055	0.005
Difference entropy	0.3966	0.2768	0.2507	0.2761	0.30005	0.0378
Information co-relation 1	-2.1522	-2.1359	-2.1175	-2.1493	-2.138725	0.0033
Information co-relation 2	0.9986	0.9991	0.9994	0.999	0.999025	0.0012
Invert difference moment	0.9979	0.9988	0.9989	0.9988	0.9986	0.0887
Invert difference normal	0.9851	0.9912	0.9923	0.9912	0.9899	0.0056

Table 2 gives the changes in the prawn chips of four different images during preparation. Feature of energy shows less significant during drying and frying of chips. Upon storage, it significantly increased to 0.24. Contrast decreased over the period of storage time. While on another side, Homegenicity and co-relation were found to be stable during the storage of the chips. The entropy trend seems to be at negative levels. However, the results agreed with the study carried out on fried a chicken nugget, which shows the homogeneity significantly increased during storage, and contrast values at minimum levels [15]. Also, some cases reported that the interaction of starch granules in different flour compositions varies with damaged and native granules of starch which results in increasing entropy and decreasing homogeneity of the samples [16]

Table 3. Feature reduction for the sample

S. no	Feature reduction	Variance
1	Contrast	0.0792
2	Dissimilarity	0.0789
3	Energy	0.2315
4	Entropy	-0.2032
5	Homogeneity	0.9606

The chips were fried in the oil, moisture evaporates which transported across the chips surface due to concentration and pressure gradients. The structure of the crust has a significant impact on its visual and aural perception [17]. Contrast, Dissimilarity, Energy, Entropy, and Homogeneity were computed for the optimized samples as shown in Table 3. Samples had more or less comparable findings, while in some cases sample had lumps with moisture, resulting in a significant degree of dissimilarity [12]

Conclusion

The image analysis features of prawn chips changed during various unit operations like frying, drying, until the storage period. The effect on higher co-relations of GLCM features on texture parameter of prawn chips over storage period can lead to suggestion of considering image processing as a non-destructive and rapid method to be used for evaluation of products which involve frying as a unit operation. Utilization of this imaging method, could serve as an online tool for monitoring and determining quality of the food products during production and storage.

Future studies should involve exploration on the effect of moisture, oil uptake, shrinkage in the final product and optimization of the flour composition using Response Surface Methodology (RSM), which creates a domain for

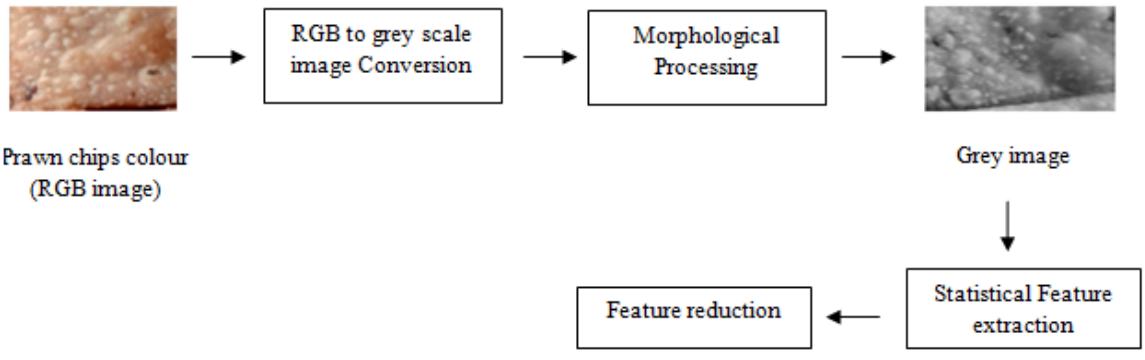

Fig. 6. Block diagram for image processing

feature extraction and classification to improve the image vision accuracy using image processing

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