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Effect of Processing on the Antinutritional Factors of Cowpea Varieties

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Abstract
Preprocessing and processing of cowpea varieties reduced the antinutritional factors. Whole gram more TIA and the vales ranged between 19.6 and 19.9 TIU/mg of protein. Among the preprocessed samples sprouted cowpea samples recorded the lower TIA (13-13.5 TIU/mg of protein) than the other samples. In the heat treated samples, puffed cowpea varieties exhibited the lowest TIA (11.6- 11.9 TTU/mg of protein) than the fried and cooked samples. With respect to flatus compounds no gas production was observed in the puffed and fried cowpea samples. Among the preprocessed methods sprouting had a significant effect on flatus compounds reduction. The variety vcP$_8$ had the lowest phytic acid and tannin content in whole gram dhal in other various processed products. Study on cooking qualities of the cowpea samples reported that the cooking time, volume expansion ratio, water absorption ratio, length and breadth elongation ratio and solid loss had increased during storage in all cowpea varieties (whole and dhal) stored in glass bottles and in polyethylene bags with and without vacuum. The utilization of cowpea in south Indian dishes seems to be very less when compared to others. The limited utilization of the cowpea could be due to (a) the ignorance of the high nutrient content and utilization method, (b) the presence of ant nutritional factors -and (c) the seasonal and also the poor storage availability characteristics of cowpea. Various processing have helped to inactivate the ant nutritional factors and to reduce the gas production rate to a greater extent in pulses and their products. It is estimated the trypsin inhibitor activity in broad beans, chickpeas, lentil, mungbean black eye pea. The trypsin inhibitor activity decreased in most of the seeds after soaking in water at room temperature for 24 h. Heat treatment at different temperatures indicated that the rate of inactivation varied with the temperature. Sin inhibitor activity of cowpea could be reduced by king, soaking, autoclaving and germination. The flatus compound present in the pulses (Cowpea and chickpea be could completely eliminated by simple cooking and fermentation process.

Keywords: Antinutritional Factors, Cowpea Varieties, Haemagglutinins

Introduction

Generally all legumes are consumed only after they have been subjected to some form of processing such as soaking, cooking, sprouting, puffing and frying. All these methods. are known to improve their palatability, alter digestibility, decrease antinutritional factors and convert vital constituents of the pulse into simpler compounds which are ultimately beneficial nutritionally (Usha Chandrasekhar *et al* 1981) [4] Although legumes are excellent source of proteins, their utilization for human food purposes is below their potential because of the presence of enzyme inhibitors, low quality proteins, flatulence compounds, strong flavors and taste. Many of the legumes contain antinutritional factors such as trypsin inhibitors, haemagglutinins and growth inhibitors, goitrogens, saponins and cyanogenic glucosides. The antinutritional factors inhibit the activity of proteolytic enzymes in the digestive tract of animals. In legume seeds protease inhibitors are widely distributed and differ in specificity and in potency of inhibition, which depends on the origin of the target enzyme (Birk, l989.Elias *et al* (1979) [6] reported that trannin concentration of cowpea was high in coloured seed costs but low in white coats seeds. Cooking decreased trannin and increased *in vitro* protein digestibility of cowpeas. Ologhobo and Fatuga (1984) [7] determined the trypain inhibitor activity ruse varieties subjected to four process namely cooking, soaking, autoclaving and germination. Theyfoudn that the trypsin inhibitor activity was completely eliminated by cooking and autoclaving whereas in the case of soaking the trypsin inhibitor activity was reduced to 31.2 per cent only.Thermal stability and changes in trypsin inhibitor during

Germination and cooking of horse gram was studied by Groped *et al* (l986) [8] they noticed that the application of dry heat at 80 °C for 60 mm did not inactivate trypsin inhibitor. In horse gram meal, only 20 per cent activity was lost when subjected to 1000C heat for 60 mm. However autoclaving of meal at 120 °C at 15 lbs pressure destroyed the inhibitor activity completely within 10 mmn. (Soaking horseg.ram seeds (8h) decreased the inhibitor activity to the extent of 30 per cent. Germination had no effect whereas germination followed by cooking resulted in 90 per cent decrease in the inhibitor activity. Aregash samuel (1996) [1] prepared bread, bun naan by combining cowpea, sorghum and refined wheat flours and noted he changes in the phytate and tannin contents, before and after preparing the products. The hydrate content of the raw flour blend ranged between 43.6 and 159.9 mg/100 g, which changed to 48.9 to 84.1, 42.92 to 71.0 and 59.9 to 69.2 for bread, bun and naan respectively. The tannin content of the raw flour blend ranged from 0.392 to 0.909 per cent which decreased to 0.35 to 0.55. 0.36 to 0.56 and 0.37 to 0.58 per cent for bread, bun and, naan respectively.

Materials and methods

Estimation of antinutritional factors Determination trypsin inhibitor activity

Benzoyl – DL-arginine –para –intro anilide (BAPNA)

The synthetic substrate BAPNA was purchased from CSIR centre for Biochemicals, Delhi was stored in a desicator inside a deep freezer.

Preparation of trypsin solution (enzyme source)

Exactly 6.25 g of lyophilized trypsin was weighed, dissolved and made up to 25 ml with 0.001 N HCL and 2ml of this stock solution was made up to 25 ml for assay. The stock solution was stored in the refrigerator and was used for one week.

Preparation of the substrate, benzoil-DL –arginine-paraintroanilide (BAPNA)

Exactly 40 mg of BAPNA, the synthetic substrates for trypsin was dissolved in one ml of dimethyl sulphoxide and was made up to 100 ml with Tris-HCL buffer. This solution, was freshly prepared every time before the experiment.

Preparation of Tris-HCL buffer

This HCL buffer of p^H 8.2 was prepared by weighting 6.05 of this (hydroxyl methyl amino methane) and 2.95 g of calcium chloride and dissolving them in 900 ml of water adjusting the pH to 8.2 with dilute HCl and by making the volume to 1000 ml with distilled water.

Assay for trypsin inhibitor activity

The trypsin inhibitor was extracted from all the samples with 25ml of pre-chilled 0.01 N Noah (Kakada *et al*., 1974) (11) by grinding in a pre-chilled mortar and pestle. These ground samples were transferred into beakers and kept in a refrigerator for 3 h with occasional shaking for complete extraction of the trypsin inhibitor.

Reinforced Clostridial medium

For the in vitro gas production experiments, reinforced clostridial medium was used.

Preparation of reinforced clostridial medium

The following ingredients are accurately weighted and dissolved in water as given by Subbarao (1977) (9).

Ingredients	Quantity
Yeast extract	3.0 g
Peptone	10.0 g
Meat extract	10.0 g
Glucose	5.0 g
Sodium acetate	5.0 g
Cysteine	0.5 g
Soluble starch	1.0 g
Agar	0.5 g
Distilled water	0.5 g

The medium was mixed well and sterilized for 20 min at 15 psi.

Expression of the trypsin inhibitor activity

Trypsin unit is defined as the amount of enzyme that liberate one u mole of tyrosine under the given assay conditions. Ti activity is expressed as trypsin units inhibited. To eliminate the possible effect of uncertainty of the extent of protein (T1) extraction in the medium, the activity was expressed as TI Units (v) per mg protein in the extract (Specific activity).

Effect of processing on the Antimitritional factors cowpea

The antinutritional factors such as trypsin factors such as inhibitors, phytic acid, tannin content and flatus compounds were analyzed after preprocessing (soaking, sprouting, and dehusking) and after processing such as cooking (boiling and pressure cooking) puffing and trying of cowpea samples selected for this study.

Soaking

The selected cowpea varieties were soaked in water in the ratio of 1.3 for 3h. The water was drained completely and surface dried by spreading on the filter paper for 2 min. The analysis of the antinutritional factors and flatus compounds were done as per the procedures given in section 3.2.4

Sprouting

Cowpea (whole) seeds were soaked in water at room temperature for six h. The soaked cowpea (whole) were kept tied in a clean sterilized cloth and was allowed to sprout at room temperature in the dark (It was found that spreading of the soaked cowpea in a moist cloth did not favour good germination). The germination was continued for a period of 24 h and the development of shoot lets and the rootlets were watched visually. The cowpea (whole) were kept moist by periodical sprinkling of water. Samples of well germinated cowpea were withdrawn and were ground well into a paste in a mortar and pestle aliquot was used for the estimation of flatus compounds trypsin inhibitor activity (TIA), tannin and phytic acid.

Cooking

Each variety of the cowpea was cooked separately by boiling method 25 g in 250 ml water for 30 min similarly 25 g of cowpea in 100 ml water was cooked in the pressure cooked for 15 mm the water was completely drained from boiled and pressure cooked samples. Surface dried then the antinutritional factors and the flatus compounds were analyzed.

Frying

The cowpea sample was soaked in the solution containing 4% sodium bicarbonate and 6% salt for at the ratio of 1:3 for 334 h. The water was completely drained, surface dried and fried in the oil for 2-234 mm at 140°C. The fried sample was ground into powder by using mortar and pestle. The ground sample was used for the analysis.

Puffing
The process developed by Subba Rao and prasannappa (1989) [9, 10]. was adopted for puffing of Cowpea with slight modifications. The cowpea sample was soaked in 4% sodium bicarbonate and 6% salt solution at the ratio of 1:3 for 33 h. Then the excess soak solution was completely drained and surface dried. The cowpea was puffed for 231 mm in a hot sand bath of 1:3 ratio maintained at 250 °C. The puffed cowpea was seived using a metal sieve 3520 and cooled. The husk was removed by rubbing manually and winnowing to obtain puffed cowpea. The puffed cowpea sample was powdered and utilized for the analysis.
The changes in the physical characteristics such. as weight, volume, bulk density and the organoleptic attributes, such as appearance, colour, texture, flavoür, taste and overall acceptability were also done for the fried and the puffed cowpea samples.

Results and discussion
Effect of processing on the antinutritional factors of cowpea varieties
In general the legumes are given some pretreatments. (soaking, sprouting and/dehusking) before utilizing for the preparation of sambar, kootu, and other savoury as well as sweet dishes. To make the legumes suitable for consumption and also to reduce the antinutritional factors. Cooking (boiling and pressure cooking) frying and puffing methods are adopted.

Trypsin inhibitor activity and flatus compounds
The effect of processing on trypsin inhibitor activity (TIA) and flatus compounds (FC) of cowpea varieties are given in the TI activity had reduced in the preprocessed and processed cowpea samples when compared to whole gram. The TI activity of whole gram cowpea samples ranged between 19.6(CW3) and 19.9(CW1) and for the dhal ranged from l2.9 (CW2) to 13.8 TIU/mg of protein (CW1. The soaked whole gram had the TI activities> 14.1- 14.9, whereas the sprouted whole gram had 13.0-13.5 TIU/mg of protein. Among the preprocessed samples the sprouted cowpea samples recorded the lower TIA than the other samples.

Table 1: Effect of processing on Trypsin inhibitor activity and flatus compounds of cowpea varieties

Treatment	Typsin inhibitor (TIU/mg of protein)				Flatus compounds (ml / 4ml broth)			
	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4
Whole gram	19.9	19.8	19.6	19.7	5.5	6.0	5.0	5.1
Dhal	13.8	12.9	13.4	13.6	3.1	3.4	3.1	2.9
Soaking (3h)	14.2	14.1	14.9	14.6	1.6	2.0	2.5	1.4
Sprouting (24h)	13.5	13.1	13.0	13.4	0.4	0.6	NGP	NGP
Boiling (30 min)	14.6	14.2	14.3	14.1	1.1	1.4	1.6	1.6
Pressure cooking (15min)	13.7	12.9	12.8	12.7	0.7	0.5	0.6	0.6
Frying (3min)	12.8	12.7	12.5	12.4	0.5	NGP	NGP	NGP
Puffing (2.5 min)	11.9	11.8	11.7	11.6	NGP	NGP	NGP	NGP

From the table it is clearly understood that the heat treated samples had lowered TIA than the non-heat treated samples. Cooking by boiling method had slightly higher TIA than cooking by pressure cooker. The puffed and fried cowpea samples had recorded 11.6-11.9 and 12.4-12.8 TIU/mg of protein respectively. Among the heat treated samples, the puffed cowpea varieties exhibited the lowest TIA than the rest.
The flatus compounds had reduced in the preprocessed and processed samples when compared to the whole gram. The variety CW2 recorded Ct highest flatus compound for both whole gram and dhal (6.0 and 3.4 ml/4ml of broth). In the soaked samples, had the highest gas production (2.5 ml/4ml of broth) and CW4 had the lowest gas production (1.4 ml/4m1 of broth) In the sprouted samples no gas production was observed in the varieties CW3 and CW4. Cooking by boiling had 1.1-1.6 and by pressure cooking it had reduced to 0.5-0.7 ml/4ml of broth. None of the puffed and fried samples produced gas except CW_1 (frying).
Kanchana (1989) [2] reported that soaking and frying of soybean reduced the trypsin inhibitor activity. TIA was not considerably reduced during soaking.

Phytic acid and trannin
The effect of preprocessing and processing on tannin and phytic acid of cowpea varieties are given in Table 16 and Figures 7 and 8. The phytic acid content of the whole, gram was found to be higher than the dhal. The phytic acid content of' whole grain cowpea samples ranged between 145.67 (CW4) and 153.80(CW1) and for the dhal ranged from126.61 (CW4) to 131.21 mg/bog (CW1) The sprouted cowpea/ samples had lesser phytic acid content than the soakedamples.

Table 2: Effect of processing on trypsin inhibitor activity and flatus compounds of cowpea varieties

Treatment	Phytic acid (mg/ 100g)				Tannin content (mg/100g)			
	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4
Whole gram	153.80	150.71	149.62	145.67	0.76	0.77	0.71	0.70
Dhal	131.21	128.71	127.68	126.61	0.69	0.65	0.63	0.60
Soaking (3h)	122.22	110.21	112.34	109.71	0.51	0.50	0.54	0.48
Sprouting (24h)	119.22	115.10	109.96	106.59	0.49	0.45	0.47	0.40
Boiling (30 min)	110.21	118.71	109.91	15.61	0.42	0.42	0.44	0.41
Pressure cooking (15min)	112.22	119.81	105.61	104.71	0.42	0.44	0.45	0.42
Frying (3min)	120.31	108.91	104.71	100.61	0.39	0.34	0.34	0.30
Puffing (2.5 min)	121.30	103.97	111.02	101.71	0.38	0.37	0.36	

Among the heat treated samples. Cooked phytic acid content than fried and puffed samples. With samples (boiling and pressure cooking) recorded the lower respect to the cooked samples the variety CW2 had exhibited the higher phytic acid content than the rest of the samples. The variety CW1 had recorded the highest phytic acid content after frying (120.31) and puffing (121.30) than the rest of the samples. Whereas, the variety CW4 had recorded the lowest phytic acid content after frying and puffing.

The tannin content of whole gram was found to be higher than the dhal. The variety (CW1) exhibited the highest tannin content (0.76 and 0.69) and the lowest tannin content (0 70 and 0 60) was found in the variety (CW4) for both whole gram and dhal The tannin content of soaked and sprouted cowpea varieties were 0 48 - 0 54 and 0 40-0 49 mg/100 g respectively.

The heat treated samples had recorded lower tannin content than the non-heat treated samples among the heat treated samples, fried and puffed samples and boiled and pressure cooked samples had more or less similar tannin content. The tannin content of the heat treated samples ranged between 0.30 (CW4) and 0.45 (cw3) and for the non-heat treated samples ranged from 0.40 (cw4) to 0.77 (CW2) mg/100 g.

Among the four varieties selected for the study the CW_4 had the lowest phytic acid and tannin content in whole gram, dhal and other various processed products.

Khan *et al* (1979) [3] observed the tannin content of some improved cowpea varieties ranging from 0.56 to 0.76 per cent. Philips (1982) [9] reported that tannin and trypsin inhibitor activity was low in cowpea flour than whole gram.

Summary and Conclusion

Effect processing on the antinutritional factors of cowpea varieties.

Practically all legumes are consumed only after they have been subjected to some form of processing such as soaking, sprouting, dehusking, boiling, pressure cocking and puffing. All these methods are known to improve their palatability digestibility and to decrease the antinutrtional factors.

Trypsin inhibitor activity and flatus compounds

Among the varieties of cowpea used for the study the TIA was maximum in whole gram sample of variety P152 (19.9 TIU/ mg of protein) and minimum in variety CO5 (19.6 TIU \mg of. protein) With respect to the preprocessing methods, the sprouted cowpea samples recorded the lowest TIA followed by dhal (dehusked) and soaked samples.

In the heat treated samples, puffing had a significant Effect on reduction of the TIA among all the varieties of puffed cowpea samples. Variety CW4 had the lowest TIA (11.6 TIU\mg of Protein.

J CThe flatus compounds for the whole gram ranged between 5.0 QCW3) and 6.0 (CW4). Dehusking of gram reduced the flatus compounds and ranged between 2.9 and 3.4 ml\4m1 of broth. Sprouting had a significant effect on the reduction of flatus compounds. In varieties CW3 and CW4 no gas production was found in the sprouted samples. Among the heat treated methods boiling for 30 mm and pressure cooking for 15 mm reduced the flatus compounds and the values ranged froth 1.1 (CW1) to 1.6 (CW3 and CW4) and from 0.5 (CW2) to 0.7 (CW1) ml\4ml of broth respectively. Complete elimination of flatus compounds was found in puffed and fried cowpea samples except CW_1 (0.5m1/4m1 of broth.

Phytic acid and tannin

The phytic acid was found to be higher in whole gram than dhal cowpea samples. The phytic acid content of whole gram cowpea samples ranged between 145.67 (CW4) and 153.80 (CW1) and for the dhal ranged from 126.61 (CW4) to 131.21 (CW1). The sprouted samples had minimum phytic acid than the soaked samples. Among the heat treated samples cooked samples (boiling and pressure cooking) recorded lower phytic acid content than fried and puffed samples.

Table 3: Changes in the cooking quality of cowpea varieties (wholegram) during storage

Characters	Glass Bottles (T_1)				Polyethylene bags without vacuum (T_2)				Polyethylene bags with vacuum (T_3)			
	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4
Cooking time (min) Zero day	453.59.5	48.552.0	49.0	49.0	49.5	48.5	49.0	49.0	49.5	48.5	49.0	49.0
180 day	53.5	52.0	53.5	52.0	53.5	52.0	53.5	52.0	53.5	52.0	53.5	52.0
Volume expansion ratio Zero day	2.2	2.2	2.01	2.1	2.2	2.2	2.01	2.1	2.2	2.2	2.01	2.1
180 day	3.4	3.5	3.5	3.5	3.4	3.5	3.5	3.5	3.4	3.5	3.5	3.5
Water absorption ratio Zero day	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
180 day	2.3	2.3	2.4	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.4	2.3
Length elongation ratio Zero day	0.5	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.5	0.4	0.4	0.4
180 day	0.9	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.9	0.8	0.8	0.9
Breadth elongation ratio Zero day	0.74	0.73	0.73	0.74	0.74	0.73	0.73	0.74	0.74	0.73	0.73	0.74
180 day	0.75	0.74	0.74	0.75	0.75	0.74	0.74	0.75	0.75	0.74	0.74	0.75
Solid loss in the gruel (g/100g) Zero day	1.35	1.30	1.35	1.35	1.30	1.35	1.35	1.30	1.35	1.35	1.30	1.35
180 day	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

Table 4: Changes in the cooking quality of cowpea varieties (Dhal) during storage

Characters	Glass Bottles (T_1)				Polyethylene bags without vacuum (T_2)				Polyethylene bags with vacuum (T_3)			
	CD_1	CD_2	CD_3	CD_4	CD_1	CD_2	CD_3	CD_4	CD_1	CD_2	CD_3	CD_4
Cooking time (min Zero day	34.5	35.5	36.0	35.0	34.5	35.5	36.0	35.0	34.5	35.5	36.0	35.0
180 day	36.5	36.5	37.0	36.0	35.5	36.5	37.0	36.0	35.5	36.5	37.0	38.0
Volume expansion ratio Zero day	3.8	3.7	3.5	3.8	3.8	3.7	3.5	3.8	3.8	3.7	3.5	3.8
180 day	4.4	4.3	4.2	4.4	4.4	4.2	4.4	4.4	4.3	4.3	4.4	4.4
Water absorption ratio Zero day	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
180 day	2.8	2.7	2.7	2.6	2.6	2.6	2.7	2.7	2.7	2.6	2.8	2.6
Length elongation ratio Zero day	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.04	1.03	1.03	1.03	1.04
180 day	1.04	1.04	1.04	1.5	1.04	1.04	1.04	1.5	1.04	1.04	1.04	1.5
Breadthelongationratio Zero day	0.60	0.61	0.62	0.64	0.60	0.61	0.62	0.64	0.60	0.61	0.62	0.64
180 day	0.65	0.66	0.65	0.67	0.65	0.66	0.65	0.67	0.65	0.66	0.65	0.66
Solid loss in the gruel (g/100g) Zero day	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
180 day	2.05	2.05	1.95	2.00	2.05	2.05	2.05	2.05	2.00	2.05	2.05	2.05

Table 5: Organoleptic Scores for the cowpea (wholegram) varieties

	Apearance				Colour				Flavour				Taste				Overall acceptability			
Treatment	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4
Control	4.0	3.9	3.9	4.0	3.9	3.9	4.0	4.0	4.0	4.0	3.9	4.0	3.9	3.8	3.8	4.0	3.9	3.9	3.9	4.0
Glass bottle (T_1)	4.0	3.9	3.9	4.0	3.9	3.9	4.0	4.0	4.0	4.0	3.9	4.0	3.9	3.8	3.8	4.0	3.9	3.9	3.9	4.0
Polythylene bags without vacuum (T_2)	4.0	3.8	3.9	4.0	3.8	38	4.0	4.0	3.9	4.0	3.9	4.0	3.8	3.7	3.7	4.0	38	38	38	4.0
Polyethylene bags with vaccum (T_3)	4.0	3.9	3.9	4.0	3.9	3.9	4.0	4.0	4.0	4.0	3.9	4.0	3.9	3.8	3.8	4.0	3.9	3.9	3.9	4.0

Maximum Score 4.0

Table 6: Organoleptic scores –for the cowpea (dhal) varieties

Treatment	Apearance				Colour				Flavour				Taste				Overall acceptability			
	Cd_1	CD_2	CD_3	CD_4	Cd_1	CD_2	CD_3	CD_4	Cd_1	CD_2	CD_3	CD_4	Cd_1	CD_2	CD_3	CD_4	Cd_1	CD_2	CD_3	CD_4
Control	4.0	3.9	3.9	4.0		3.9	3.9	4.0	4.0	3.9	3.9	4.0	3.9	3.9	3.9	4.0	3.9		3.9	4.0
Glass bottle (T_1)	4.0	3.9	3.9	4.0		3.9	3.9	4.0	4.0	3.9	3.9	4.0	3.9	3.9	3.9	4.0	3.9		3.9	4.0
Polythylene bags without vacuum (T_2)	4.0	3.8	3.9	4.0		3.8	3.9	4.0	4.0	3.9	3.9	4.0	3.8	3.8	3.9	4.0	3.9		3.9	4.0
Polyethylene bags with vaccum (T_3)	4.0	3.9	3.9	4.0		3.9	3.9	4.0	4.0	3.9	3.9	4.0	3.9	3.9	3.9	4.0	3.9		3.9	4.0

Maximum Score 4.0

Table 7: Organoleptic Evaluation of Puffed and fried cowpea varieties (%)

Attributes	Puffed				Fried			
	CW_1	CW_2	CW_3	CW_4	CW_1	CW_2	CW_3	CW_4
Appearance	65.5	75.5	80.0	100.0	50.0	58.5	70.5	100.0
Colour	70.0	80.5	85.5	98.5	62.5	74.5	80.5	98.5
Flavour	65.0	80.5	80.5	97.5	75.0	77.5	82.5	98.0
Texture	60.5	70.5	80.0	98.5	77.5	80.0	83.5	98.5
Taste	58.5	75.0	82.5	98.0	80.0	83.0	85.5	100.0
Overall acceptability	60.5	78.5	81.0	98.0	70.0	73.5	80.0	97.0

The tannin content was found to be maximum in variety CW_1 for both whole gram and dhal and the values were 0.76 and 0.69 (mg/bog) and minimum in variety CW_4. There was a education in tannin content of cowpea samples when subjected to sprouting and soaking. The heated samples had a minimum tannin content of 0.30 (CW_4) and maximum of 0.45mg/bog (CW_3). Among the four varieties selected for the study CW_4 had the lowest phytic acid and tannin content in the whole gram, dhal and other various processed Products.

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