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DEGRADATION OF CHLOROPHYLL DURING DRYING AND STORAGE OF LEAF PROTEIN CONCENTRATE

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Leaf protein concentrate (LPC) containing up to 60% protein is being industrially produced in many countries as a substitute for the conventional sources of Protein.[1] Presentation of LPC on the table has been a hurdle due to consumers' prejudice against the green colour. Luckily foods such as spinach curry containing meat are considered as delicacy. A paste (chutney) prepared from vegetable leaves, green chillies and salt is very popular diet amongst the poor populace.

Degradation of chlorophyll during the preparation of LPC has been recently studied.[2] The present investigations were carried out to determine the loss of chlorophyll in LPC during storage under different conditions.

Experimental

LPC was obtained from *Trifolium alexandrinum* by the method of Morrison and Pirie,[3] washed either with water or with 1.5N HCl (pH 4) and then pressed using IBP press. Low-moisture LPC cake (dry matter 40%) was loosely spread in trays up to a thickness of 0.5 cm and then dried in a cabinet dehydrater under hot air blow at 70±5°C for 2½ hr.[4] LPC (250 g) which passed through 80 mesh sieves was packed in 500-g amber-coloured and colourless screwed top glass containers. One lot of the bottles was kept at ambient temperature on table shelf and the other at 5°C in a refrigerator. Retention of chlorophyll was determined at 30 days intervals to a storage period of 120 days) following A.O.A.C. methods.[5]

Results and Discussion

Loss of Chlorophyll on Drying. The amount of chlorophyll in acid - and water-washed cakes was 2.89 mg/g and 2.93 mg/g respectively. The corresponding percentage losses of chlorophyll on drying were 47.0 and 48.1% respectively (Table 1). This was expected, as chlorophyll has been reported to be extremely sensitive to heat.[6] Drying of soybean and nasturtium leaves even at 24° C has been reported to cause a loss of 30% in the chlorophyll content, although the rate of loss of chlorophyll in leaves is expected to be low due to its presence inside the plant tissue. However, it is evident from the results that pretreatment of the cake with water or acid did not help in chlorophyll retention.

Loss of Chlorophyll During Storage. The rate of loss of chlorophyll, during storage, appeared to depend on pretreatment of the sample (water-or acid-washed), colour of the package, and storage time and temperature.

The rate of chlorophyll decomposition appeared to be lower in the acid washed samples than in the water-washed samples (Fig. 1). This may be attributed to the removal of hydrolysable sugars and carbohydrates during the acid washing process. Sugars have been reported to catalyse the decomposition of chlorophyll. However, the process has been reported to be temperature dependent as no catalysis was observed at 10° C.[8] This seems to be the reasons for the wider difference in the rates of chlorophyll

Table 1. Chlorophyll Contents of Fresh and Stored Leaf Protein Concentrate.

Storage Temperature	LPC Sample	Fresh cake			Stored: 30 days				Stored: 60 days				Stored: 90 days			
		Wet mg/g	Dry mg/g	Loss on drying %	A.C.P* mg/g	Loss on storage %	C.L.P. mg/g	Loss† on storage %	A.C.P* mg/g	Loss on storage %	C.L.P† mg/g	Loss on storage %	A.C.P. mg/g	Loss on storage %	C.L.P† mg/g	Loss) on Storage %
5°C	Water-washed	2.89	1.53	47.0	1.53	0.0	1.48	3.2	1.53	0.0	1.45	5.2	1.53	0.0	1.33	13.0
	Acid-washed	2.93	1.52	48.1	1.52	0.0	1.50	1.3	1.52	0.0	1.50	1.3	1.52	0.0	1.46	3.9
	Water-washed	2.89	1.53	47.0	1.07	30.0	0.98	36.0	0·78	49.0	0.75	50.9	0.71	53.6	0.65	57.5
	Acid-washed	2.93	1.52	48.1	1.37	9.9	1.12	26.0	1.22	19.7	0.89	41.4	1.11	27.0	0.85	44.0

*Amber coloured package. †Colourless package.

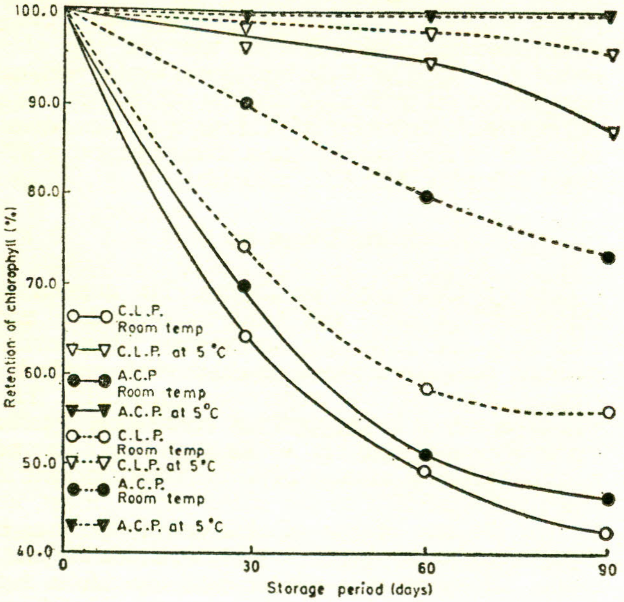

Fig 1. Percentage retention of chlorophyll in stored LPC
C.L.P. =Colourless Package ....Water Washed LPC
A.C.P. =Amber Coloured Package——AcidWashed LPC.

decomposition of the two samples at ambient temperature than at 5°C.

The rate of loss of chlorophyll in both the samples (acid as well as water-washed) was extremely slow during the first two months at 5°C and was accelerated during the third month (Fig. 1). However, the pattern was different in case of samples stored at ambient temperature. The rate of decomposition was maximum during the first month of storage which slowed down during the subsequent months (Fig. 1).

Water-washed samples stored at 5°C in colourless packages showed a loss of 13.0% on three months storage. The corresponding losses at ambient temperature for colourless and amber-coloured packages were 57.5 and 53.6% respectively (TABLE 1).

The rate of decomposition of chlorophyll in LPC samples stored in amber-coloured packages was always found to be lower than those in colourless packages. The rate of decomposition of chlorophyll has been reported to be dependent on light intensity,[9] Amber-coloured packages were found to be more protective at 5°C than at the ambient temperature. This was also expected in view of the higher light intensity to which samples were exposed at ambient temperatures.

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EFFECT OF HIGH DOSES OF PHOSPHORUS IN THE PRESENCE OF THREE LEVELS OF NITROGEN ON THE PHYSICOCHEMICAL CHARACTERISTICS OF COTTON LINT

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The object of the present investigation was to study the effect of high doses of phosphorus in the presence of three levels of nitrogen on the quality of cotton lint.

Methods and Materials

This work was conducted at Agricultural Research Substation Serai Naurang (N.W.F.P.) The variety of cotton 13/26 was sown in the year 1972. The experimental design was factorial with four replications. Various treatments of nitrogen and phosphours were applied (Table 1).

Soil Analysis. Soil characteristics were determined before sowing. Total nitrogen, lime contents, organic matter, pH value, available potash and available phosphrous were determined by the methods as outlined by Jackson.[1] Texture of soil was determined by the method of hydrometer using USDA-size particle system.

Cotton Lint Analysis. The diameter of the fibre was determined according to Bergenand([13]) employing a pojection microscope. Fibre length was determined by the Tuft method, and length being measured against a ruler as given by Khan *etal.*[8] Fineness was determined on the Shefield micronaire.[2] Tensile strength was determined by pressely strength tester using the flat bundle method, according to ASTM method.[3] Moisture, ash, chemical damage and oxycellulose were determined by Skinkle, [10] dye absorbaning according to Trotman[9] and the shade was compared with the control sample. Crude wax was extracted by Soxhlet apparatus using pertoleum ether (b.p. 40-60°C).[4] Cellulose was determined by the Howlett method involving heating with 10% nitric acid. The samples were tested for oxycellulose with methylene blue.[1]

Results and Discussion

Soil Characteristics

Representative soil sample was analysed before laying out the trial. It was found that the soil was loamy in texture, calcareous and had a pH of 8.1. The soil contained 240 p.p.m. available K_2O, 25 p.p.m. available P_2O_5 and 0.9% organic matter.

Effect of Nitrogen and Phosphorus on Cotton Lint Characteristics

Diameter. The diameter of the cotton lint was not affected by the application of nitrogen and phosphorus except with one single high dose of phosphorus. In other words maximum diameter or cotton lint resulted in from a fertilizer combination of 80 lb nitrogen and 240 lb P_2O_5per acre. It was concluded that the quality of the fibre was deteriorated with the increase in the doses of nitrogen and phsophorus.

Fibre Length. The variations in length with nitrogen and phsohporus application were almost negligible and did not show any consistent pattern. The material collected in the third picking of the cotton gave the maximum length of the fibre and this confirmed the findings of Perkins.[7]

Fineness. The fineness of the cotton lint was least affected with the application of nitrogen and phosphorus fertilizers (Table 1). The results were in conformity with those reported by Perkins.[7] The phosphorus dosage was, however, negatively correlated with micronaire values. The coefficients of correlation(r) were found to be 0.29, 0.45, 0.21 (all in significant) when 0,40 and 80lb N per acre were applied with combinations of 0, 60, 120, 180 and 240 P_2O_5 per acre.

Tensile Strength. The tensile strength increased in general with the application of nitrogen and phosphorus fertilizers (Table 1). High doses of nitrogen, however, decreased the tensile strength of the fibre. This effect of nitrogen seemed to be counteracted by the high doses of phosphorus. Maximum tensile strength was obtained with 40 lb N and 240 lb P. This might be explained on the basis that high amount of phosphorus and adequate amount of potassium (orignally present in the soil) in the presence of nitrogen hastened the maturity of the fibre, which resulted in an increase of fibre strength. The effect of phosphorus was positively correlated with tensile strength. The coefficients of correlation (r) were 0.86, 0.68, 0.58, when O, 40 and 80 lb N per acre were applied with a combination of 0.60, 120, 180 and 240 lb P_2O_5 per acre.

Crude Wax. The crude wax percentage in cotton lint increased with vrious fertilizer treatments (Table 1). However, 4o lb N in combination with 240 lb P_2O_5 per acre gave the least amount of crude wax. There were also a few more exceptions, which were difficult to explain due to lack of sufficient data. The wax contents varied from one picking to the other. The percentage decreased as the plant advanced in maturity.

Ash Percentage. The ash percentage in the cotton lint increased with the application of N and P (Table 1). When P alone was used it was found that ash percentage incrased with the high doses of P, i.e. 120, 180, 240 P_2O_5 per acre. The effect of P was positively correlated with the ash percentage. The coefficient of correlation (r) were found to be 0.54, 0.56, 0.43 when 0, 40, 80 lb N per acre were applied with combinations of 0, 60, 120, 180 and 240 lb P_2O_5 per acre.

Cellulose. The cellulose percentage in general greatly increased with the application of N and P

TABLE 1. EFFECT OF HIGH DOSES OF PHOSPHORUS IN COMBINATION WITH NITROGEN ON SOME PHYSICOCHEMICAL CHARACTERISTICS OF COTTON LINT.

Fertilizers treatments N - P_2O_5 lb/acre	Dia† (μ)	Fibre* length (mm)	Fineness* (mg/cm)	Tensile* strength (100 lb in^2)	Crude wax (%)	Ash* (%)	Cellulose* (%)
0 0	15.8	27.4	5.1	79.0	0.3	1.1	85.5
0 60	17.2	23.7	4.9	80.0	0.4	1.3	87.1
0 120	15.4	25.5	4.8	79.9	0.4	1.4	87.7
0 130	15.4	25.5	4.8	79.9	0.4	1.4	87.7
0 180	15.6	24.3	4.7	82.5	0.4	1.2	87.2
0 240	13.7	24.7	5.0	83.7	0.4	1.5	86.4
40 0	16.5	24.5	5.0	79.1	0.4	1.3	87.3
40 60	16.5	24.3	4.9	78.6	0.5	1.4	89.0
40 120	15.2	25.2	4.9	80.2	0.5	1.5	87.4
40 180	15.4	24.8	4.8	82.4	0.3	1.3	88.0
40 240	16.0	23.7	4.9	84.8	0.3	1.6	88.2
80 0	16.4	23.0	4.7	78.5	0.3	1.3	87.3
80 60	15.7	23.3	4.8	80.7	0.4	1.4	88.7
80 120	15.5	24.0	4.8	82.3	0.4	1.5	88.5
80 180	15.7	23.3	4.7	83.1	0.5	1.4	87.8
80 240	18.0	24.9	4.8	83.0	0.4	1.6	88.5

*Represents the mean of three applications.

(Table 1). The results supported the finding of Wahab and Hussain,[5] effect of P was positively correlated with cellulose percentage of cotton lint.

Dye Absorbing Power. All the samples were dyed under the same conditions. The dyed samples after drying were compared visually, no differences in shades were noted. It was concluded that the application of N and P had no effect on dye absorbing power.

Oxycellulose. No oxycellulose was detected, which mean that the samples were not damaged. It might be concluded that the cotton fibres were not damaged in the field by the application of the various levels of fertilizers.

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