CHEMICAL CHANGES DURING MALTING OF CEREALS

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The digestibility of wheat, maize and sorghum increased when the seeds were germinated. Kilning of these seeds imparted an appetizing flavour to the malted flour. Vitamin B_1, soluble amino acids and soluble sugars were determined at various stages of germination and were maximum in wheat seeds.

Cereals such as Wheat (*Triticum vulgcre*), Maize (*Zeae maize*), Jawar (*Andropogon sorghum*) and Rice (*Oryza sativa*) supply proteins, minerals and vitamins in addition to carbohydrates. The digestibility of cereals and their products depend on the method of their cooking and metabolic system of the person consuming them.

The digestibility of the cereals can be increased simply by boiling as reported by Csapo *et al.*[1] but to render soluble most of the food material contained in the grain, the process of malting is resorted to. During germination, the diastatic and proteolytic break-down is fairly elaborate which results in the formation of readily assimilable diet.

Loilel,[2] while studying the bio-chemistry of cereals, during germination, observed an increase in the soluble substances in the endosperm of the germinating seeds. The decrease in starch contents was partly due to the respiration and partly through the fermentation of soluble carbohydrates. Sasaki [3] studied the carbohydrate metabolism of soya bean during germination and noted an increase in the amount of reducing sugars and dextrin. Anderson *et al.*[4] determined a loss in the protein and an increase in soluble nitrogen contents during malting of wheat. A slight loss of thiamine during malting was reported by Hlavaty[5] and Organ *et al.*[6] Lecoq[7] prepared malt soups for convalescents and growing children. Chandrasekhara *et al.*[8] suggested the preparation of malt foods from Jawar (*Sorghum*). Such foods are usually fortified with vitamins and minerals and other nutrients.

The purpose of the present investigation was to develop an economical method for infant foods from cereals by increasing their digestibility by germination. Hence the present work includes the study of changes in free amino-acids, soluble sugars and vitamins B_1 contents at various stages of malting.

Experimental

Seeds of wheat, maize and jawar, after removal of chaff, dust, stones and damaged seeds, were steeped in lime water for one day and then in water for two days at 28°C. The seeds were then spread over jute mattings and placed on wire gauze stand, for germination. The germination was continued at 28°C. till the sprouts attained an average length of one inch. The jute mats were kept wet during this period.

1. *Steeping in Lime Water.*—The healthy seeds were steeped in lime water (pH 8) at 28°C. for 24 hours.

2. *Steeping in Water.*—The cereals steeped in lime water were washed and kept in water at 28°C. for two days.

3. *Germination.*—The cereals steeped in water were spread over jute mattings. Germination was continued till the sprouts attained an average length of one inch.

4. *Steeping in Sulphuric Acid.*—The germinated seeds were steeped in 15 percent sulphuric acid for 24 hours to further increase the digestibility of the cereals. The excess of the acid was then removed by giving the seeds a thorough washing under tap water.

5. *Kilning.*—Finally the seeds were placed in an oven and heated at 78°C. for six hours. This checked the enzymatic activity and helped in developing a pleasant flavour in the malt.

The chemical changes during germination were studied by estimating soluble sugars, soluble nitrogen and vitamin B_1.

Soluble Sugars.—The soluble sugars were estimated by Somogyi's Iodometric method.[9]

Nitrogen.—The soluble nitrogen was extracted with 10 percent trichloroacetic acid and estimated by a micro-Kjeldahl method.

Thiamine.—The thiaimne contents of various extracts were determined by thio-chrome[10] method using Hilger flourimeter. The dry matter of the samples was also estimated by keeping them in an hot air oven at 105°C. for 24 hours.

Soluble Matter.—2.0 g. weights of the samples were taken in 100 ml. centrifuge tube and were suspended in 25 ml. of water. The tubes were centrifuged at 2500 r.p.m., for 15 minutes and the supernatent liquid was removed. The process was repeated three times and the residue left over was dried to constant weight.

TABLE 1.—CHANGES IN THE SOLUBILITY OF CEREAL SEEDS DURING MALTING. SOLUBLE MATTER (Percent).

	Seeds		Flour	Malt
1.	Jawar	..	17.2	36.1
2.	Maize	..	20.0	31.2
3.	Wheat	..	19.1	38.6

Results and Discussion

The soluble nitrogen contents of the seeds increased from 0.08% to 0.30% during steeping. It increased still further when the seeds were germinated for five days. In jawar, the increase was from 11.5 to 33.5 while in maize and wheat 18 to 35 and 36 to 60 mg./g. respectively (Tables 2, 3 and 4). This increase was due to the activation of proteolytic enzymes which breakdown the complex protein molecules into simpler units of soluble amino acids. The increase in soluble nitrogen in germinated seeds was also reported by Anderson *et al.*[4]

There was an increase in the soluble sugars when the seeds were germinated after steeping. Wheat seeds showed the maximum increase from 2.1 to7 0.6 mg./g. whereas the increase in maize and jawar was from 1.89 to 43 mg./g. and 1.46 to 36 mg./g., respectively. The hydrolysis of polysaccharides to soluble sugars, during germination, was observed by Loilel[2] and Sasaki.[3]

To further increase the digestibility, the germinated seeds were steeped in dilute sulphuric acid. Wheat showed maximum hydrolysis.

The decrease, in the soluble nitrogen and sugar, after kilning of germinated seeds was presumably due to the combination of sugars with amino acids-Maillard's Reaction.[11] The pleasant flavour imparted to the kilned malt also confirmed the condensation of amino acids and sugars to form the Mellanoidins. Vitamin B_1 contents of the seeds changed slightly during germination.

The malt flour obtained from wheat, contained maximum amount of soluble nitrogen, soluble sugars and vitamin B_1. The solubility of the wheat malt was also maximum. It has an appetizing aroma as well. These results showed that wheat malt could be used for the preparation of infant food.

TABLE 2.—CHEMICAL CHANGES DURING MALTING IN MAIZE (RESULTS ON DRY BASIS).

No.	Stage		DM%*	Thiamine mg./100g.	Nitrogen mg./100 g.		Soluble sugars mg./100 g.
					Total	Soluble	
1.	Seed Flour	.. ..	84.3	0.498	1490	96	189
2.	Lime Steep	.. ..	67.6	0.473	1491	156	760
3.	Water Steep	.. ..	58.3	0.455	1492	180	1730
4.	Germination	.. ..	58.0	0.362	1498	347	4310
5.	H_2SO_4 Steep	.. ..	52.0	0.362	1496	375	4400
6.	Kilning	.. ..	90.9	0.360	1501	285	3245

* Dry Matter percent.

TABLE 3.—CHEMICAL CHANGES DURING MALTING IN JAWAR

No.	Stage	DM%	Thiamine mg./100 g.	Nitrogen mg./100 g.		Soluble sugars mg./100 g.
				Total	Soluble	
1.	Seed Flour	85.5	0.430	2064	81.87	146
2.	Lime Steep	64.0	0.390	2067	98.43	453
3.	Water Steep	59.5	0.360	2075	117.54	1050
4.	Germination	48.0	0.291	2072	333.30	3613
5.	H_2SO_4 Steep	40.0	0.290	2070	350.00	3712
6.	Kilning	86.2	0.293	2060	197.05	2552

TABLE 4.—CHEMICAL CHANGES DURING MALTING IN WHEAT.

No.	Stage	DM%	Thiamine mg./100g	Nitrogen mg/100 g.		Soluble sugars mg./100 g.
				Total	Soluble	
1.	Seed Flour	91.0	0.560	2072	198	210
2.	Lime Steep	62.0	0.545	2100	295	880
3.	Water Steep	49.0	0.538	2091	360	1930
4.	Germination	50.7	0.472	2108	598	7060
5.	H_2SO_4 Steep	50.0	0.470	2103	613	7370
6.	Kilning	91.5	0.465	2106	365	5450

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