Lysine-Infused Popcorn

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ABSTRACT

The lysine content of commercial yellow popcorn was increased by infusing kernels with aqueous solutions of L-lysine monohydrochloride. Infusion studies included examination of a number of time, temperature, and concentration variables. Lysine content was increased from 0.32% in unprocessed kernels to 3.0% in infused. Approximately 61% of the lysine in infused kernels was recovered when they were popped. Relative popping expansion of an infused corn sample containing 1% lysine was 70% of that with noninfused popcorn. Relative popping expansions of 60 and 55% occurred at the 2 and 3% lysine levels, respectively. No significant difference was detected in flavor between popped samples, either noninfused or infused.

Proteins in ordinary cereals lack sufficient lysine and, therefore, have less desirable amino acid patterns than do animal proteins (1). To overcome this deficiency in corn, two general approaches are being investigated: development of new varieties having increased levels of lysine and tryptophan (2) and addition of limiting amino acids to commercial grains or grain products. Although studies have been conducted on the fortification of wheat (3) and dent corn (4) by infusion with lysine, none have been carried out with popcorn. This paper describes the effects of infusion of popcorn with lysine on popping expansion, lysine recovery, and flavor.

MATERIALS AND METHODS

Yellow popcorn was purchased in a 50-lb. lot from a local distributor. Moisture level was adjusted to 13.5% during a 14-day equilibration period. L-Lysine monohydrochloride, F.C.C., was obtained from Merck Chemical Division, Merck & Co., Inc., Rahway, N.J.

Infusion studies were conducted with 1,000-g. samples of corn submerged in 2,000 ml. of an aqueous solution of L-lysine monohydrochloride. The lysine solution was decanted and the grain washed with three 2,000-ml. volumes of water to remove any lysine on the surface of the kernels. The corn was drained, air-dried to 13.5% moisture, and equilibrated for 14 days in sealed containers at room temperature (5).

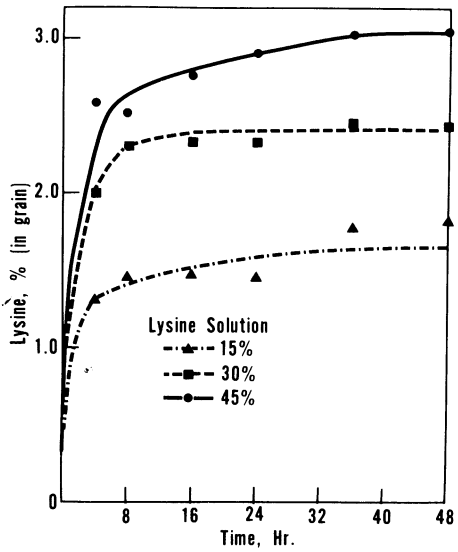
The corn was popped in a Teflon-coated automatic electric corn popper of 4-qt. capacity (Model No. 302.68700, Sears, Roebuck and Co.). The operator has no control over either the initial popping temperature or the duration of the popping cycle with this unit. Five tablespoons (72 g.) of unsalted corn oil and two-thirds

[1]This is a laboratory of the Northern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture. The mention of firm names or trade products does not imply that they are endorsed or recommended by the U. S. Department of Agriculture over other firms or similar products not mentioned.

cup (120 g.) of popcorn were used for each batch. Popping expansions were determined by measuring volumes of unpopped and popped corn in a graduate. Lysine was determined with a Technicon AutoAnalyzer on hydrochloric acid hydrolysates of ground whole-corn samples. Moistures were measured with a Cenco moisture balance, Model No. 026680-1 (Central Scientific Co., Chicago, Ill.). All values are reported on a moisture- or popping oil-free basis, or both.

RESULTS AND DISCUSSION

Infusion studies included an examination of time, temperature, and concentration variables. The influence of time on lysine infusion was studied at 75° and 160°F. with 15, 30, and 45% lysine solutions. Data at 75°F. were obtained with infusion periods of 4, 8, 16, 24, 36, and 48 hr. (Fig. 1). Lysine concentration in the kernels increased rapidly during an infusion period of up to approximately 6 hr. From 6 to 48 hr. infusion was at a much slower rate than during the preceding 6 hr. Various levels of lysine ranging from 0.32% (content of the original corn) to 3% were obtained in the infused product by using different combinations of time and lysine concentration. Data at 160°F. were obtained with infusion periods of 15, 30, 45, and 60 min. (Fig. 2). An infusion time of up to 30 min. produced a fairly rapid increase in lysine concentration in the corn. Increasing the infusion time from 30 to 60 min. did not increase lysine level in the grain appreciably. A higher maximum lysine level (approximately 3%) in the popcorn was obtained at 75°F. than at 160°F. (approximately 2%).



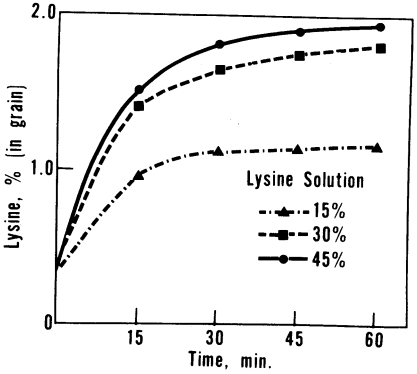
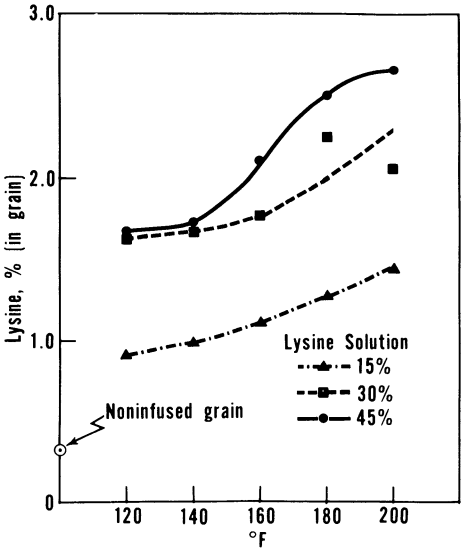


Fig. 1 (left). Effect of time on infusion of lysine in popcorn (infusion temperature 75°F.).

Fig. 2 (right). Effect of time on infusion of lysine in popcorn (infusion temperature 160°F.).



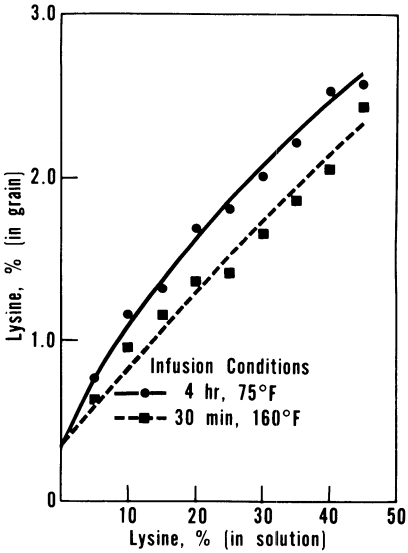


Fig. 3 (left). Effect of temperature on infusion of lysine in popcorn (infusion time 30 min.).

Fig. 4 (right). Effect of concentration on infusion of lysine in popcorn.

The influence of temperature on lysine infusion was studied with 15, 30, and 45% lysine solutions during a 30-min. infusion (Fig. 3). Lysine content of the grain increased with all three lysine solutions when the temperature was increased from 120° to 200°F. From 120° to 140°F. the 45% lysine solution produced little additional infusion of lysine beyond that produced with the 30% lysine solution. Infusion temperatures of 160°F. or lower are preferred to prevent possible heat damage to the popcorn.

The influence of concentration of lysine on lysine infusion was studied under two sets of conditions. One involved an infusion time of 4 hr. at a temperature of 75°F.; the other, 30 min. at 160°F. (Fig. 4). Curves produced with data from the two sets of conditions are similar. Increasing the concentration of lysine in solution up to 45% increased lysine content in the popcorn from its original value of 0.32% up to approximately 2.5%.

The effect of popping on lysine recovery was examined in the original popcorn and in 16 samples of popcorn infused at both 75° and 160°F. Lysine content in the infused samples ranged from 0.86 to 3.27% (Table I). Recovery of lysine in the original popped corn was 84%, whereas recoveries in the popped infused samples ranged from 33 to 78%, with an average recovery of 61%. No significant correlation was indicated either between lysine concentration or mode of infusion and lysine recovery in the popped corn.

The same 16 samples were used to determine the effect of lysine on popping expansion of infused popcorn (Fig. 5). The noninfused sample, which had excellent popping expansion characteristics, was assigned a value of 100. Popping expansions of the infused samples are reported as a percentage of the expansion obtained with the noninfused control sample. Relative popping expansions of the infused samples

TABLE I. EFFECT OF POPPING ON RECOVERY OF LYSINE FROM INFUSED POPCORN

Infusion Temperature °F.	Total Lysine Content: Unpopped corn[a] %	Popped corn[b] %	Recovered in popped corn %	Infusion Temperature °F.	Total Lysine Content: Unpopped corn[a] %	Popped corn[b] %	Recovered in popped corn %
Original	0.32	0.27	84	75	1.67	1.29	77
160	0.86	0.31	36	160	1.81	1.29	71
160	1.00	0.69	69	75	2.10	1.29	61
75	1.13	0.59	52	75	2.27	1.08	48
75	1.28	0.98	77	75	2.57	1.59	62
160	1.39	0.80	58	75	2.64	1.78	67
75	1.49	0.49	33	75	2.91	1.98	68
160	1.51	0.90	60	75	3.27	1.98	61
160	1.65	1.29	78			Average recovery[c]	61

[a]Moisture-free basis.
[b]Moisture- and popping oil-free basis.
[c]Infused samples.

ranged from 75% at the 0.86% lysine level to 54% at the 3.27% lysine level. Increasing lysine content of the infused grain significantly lowered popping expansion. However, the type of infusion apparently is of little significance, since data shown in Fig. 5 were produced under various conditions of time, temperature, and concentration.

During popping the infused samples lost moisture at a much faster rate than did the noninfused samples. Perhaps infusion and subsequent drying enlarged the opening in the tip cap and permitted a faster moisture release. Although not investigated, a higher popping temperature might improve popping expansion characteristics by causing the corn to pop in a shorter time and therefore prevent the loss of moisture before popping.

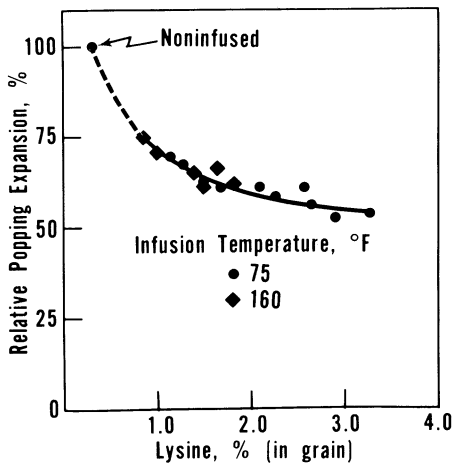


Fig. 5. Effect of lysine on popping expansion of infused popcorn.

A taste panel composed of ten people was not able to detect significant flavor differences between the popped noninfused popcorn and infused samples at the 1% lysine level.

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