# Turf Grass Dehydration

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Low losses of carotene (1–8%), total xanthophyll (10–22%), and nonepoxide xanthophyll (4–30%) occurred during dehydration of turf grass clippings. The essential amino acids were stable except during dehydration to the lowest meal moisture level. Stability of the carotenoids and amino acids was attributed to the rapid drying time of the grass. Xanthophyll stability during storage was highest in the meal dried to the lowest moisture level.

In recent years increasing quantities of turf grass are being grown throughout the United States for use as instant lawns. Growing practices require regular mowing of the grass during development of the turf, resulting in a constant supply of clippings which, if uncollected, may constitute an insect or disease reservoir in the developing turf.

Prior studies at this laboratory have demonstrated that by carefully controlling the dehydrating conditions, a high quality feed ingredient suitable for poultry feeds and rich in xanthophyll and carotene, as well as other nutrients, may be prepared from alfalfa (Livingston *et al.*, 1966, 1968, 1970). Wilkinson and Barbee (1968) found that dehydrated coastal bermuda grass and pearl millet were pigment sources as effective as dehydrated alfalfa or corn gluten meal when fed at comparable xanthophyll levels to broilers. A later investigation also showed that these two grasses could be economically dehydrated to give a high quality feed additive rich in carotene and xanthophyll (Butler *et al.*, 1969).

The present investigation was undertaken to determine optimum conditions for dehydration of turf grass clippings to produce a valuable feed ingredient from a plant waste product.

## MATERIALS AND METHODS

A pilot scale Arnold dehydrator (Model SD45-12) with a rated capacity of 1000 lb of water per hour was employed. The dehydrator was operated with a variable speed fan on the outlet side of the cyclone to regulate carefully the meal flow rate. Gas flow to the burner was automatic, depending on the quantity of fresh plant material entering the drum, thereby maintaining a constant outlet temperature.

Fresh grass samples were collected in plastic bags at the dehydrator elevator, quickly frozen with Dry Ice, and later freeze-dried. Both the freeze-dried and dehydrated grass were ground through a No. 40 screen and analyzed for total xanthophyll and carotene by the procedure of Livingston *et al.* (1971) and for nonepoxide xanthophyll by the procedure of Livingston *et al.* (1969).

The amino acids were determined by the modified ion exchange chromatography procedure of Kohler and Palter (1967) on a modified Phoenix amino acid analyzer.

The grasses dehydrated were: in trial 1, a local lawn mixture composed principally of bent and blue grass; trial 2, custom blue grass of Warren Turf Nursery; trial 3, a custom blue grass of California Turf Nursery.

Storage stability studies were carried out by storing 1-g samples of the various grass meals in open shell vials in a constant temperature chamber at 90° F with circulating air. Samples of each grass meal were analyzed periodically for carotene, total xanthophyll, and nonepoxide xanthophyll.

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## RESULTS AND DISCUSSION

**Dehydration.** Dehydration of local lawn turf grass demonstrated that a high quality feed ingredient for poultry could be prepared by dehydration of lawn clippings (Table I, Trial 1). The low temperature of dehydration as well as the short throughput time of the dried grass resulted in only moderate loss of xanthophyll. Due to the high initial xanthophyll content of the fresh grass and the good retention during drying, the dried product was very high in total xanthophyll as well as in pigmenting nonepoxide xanthophylls. The high protein and low fiber of the dehydrated meal were also indicative of a good quality poultry feed (Table II, Trial 1). These results led to additional studies (Trials 2 and 3) in which commercially grown turf grass clippings were brought to the laboratory and dehydrated.

In these studies both the outlet temperature of the dehydrator as well as the fan speed were varied in order to determine optimum drying conditions. Increasing the fan speed decreased the retention time in the dehydrator, resulting in higher meal moisture and increased xanthophyll stability. The retention time of the grass clippings was much less than that found for alfalfa in a previous study (Livingston *et al.*, 1969). The relatively greater surface area in the case of the grass clippings no doubt accounts for this difference. Little carotene was lost in any of three dehydration trials. This is in accord with the previous studies on dehydration of alfalfa where only small losses of carotene were found compared to considerable losses of xanthophyll under certain alfalfa dehydration conditions (Livingston *et al.*, 1966).

Trial 3 was conducted in an effort to prepare dehydrated grass of higher moisture levels than had been prepared in the initial trials. The fan was operated at maximum speed while the outlet temperature was reduced. The moisture of the meal was thereby increased to 4.5%, resulting in only a 10% loss of xanthophyll during dehydration.

Proximate analyses of the grass meals were also obtained following freeze-drying and after dehydration. The results are presented in Table II. There was only slight loss of either protein or fat during dehydration. The protein content of the dried grass was equivalent to that of a high quality leaf fraction of dehydrated alfalfa (Chrisman and Kohler, 1968). Although there was no significant change in the total protein during the dehydration trials, five of the six dehydrated meals had a lower percent of total fat than did the corresponding freeze-dried meals. The fat content of the dehydrated meal is valuable in determining total energy available for feed ingredients. Low fiber levels are also

Table I. Xanthophyll and Carotene Stability during Turf Grass Dehydration

| Trial | Outlet temperature of dryer, °F | Time in dryer, min | Fan speed, rpm | Moisture of meal, % | Carotene, mg/kg[a] Freeze-dried | Carotene, mg/kg[a] Dehydrated | Total xanthophyll, mg/kg[a] Freeze-dried | Total xanthophyll, mg/kg[a] Dehydrated | Nonepoxide xanthophyll, mg/kg[a] Freeze-dried | Nonepoxide xanthophyll, mg/kg[a] Dehydrated |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 235 | 3 | 1800 | 2.6 | 420 | 420 | 1094 | 857 | 854 | 599 |
| II | 270 | 3 | 1800 | 1.2 | 548 | 544 | 1248 | 830 | 840 | 747 |
| | 270 | 2.5 | 2100 | 1.7 | 528 | 511 | 1225 | 976 | 828 | 796 |
| | 250 | 3 | 1800 | 1.5 | 532 | 528 | 1235 | 1034 | 832 | 772 |
| | 250 | 2.5 | 2100 | 2.2 | 544 | 524 | 1324 | 1186 | 882 | 798 |
| III | 250 | 2.5 | 2100 | 2.4 | 438 | 419 | 1120 | 876 | 787 | 708 |
| | 235 | 2.5 | 2100 | 3.4 | 447 | 414 | 1100 | 979 | 776 | 732 |
| | 220 | 2.5 | 2100 | 4.5 | 465 | 427 | 1245 | 1107 | 830 | 747 |

[a] Moisture-free basis.

Table II. Proximate Analysis[a] of Turf Grass Following Freeze-Drying or Dehydration

| Trial | Drying procedure | Meal moisture, % | Protein, % | Fat, % | Fiber, % | Ash, % | Calcium, % | Phosphorus, % |
|---|---|---|---|---|---|---|---|---|
| I | Freeze-dried | 2.0 | 22.9 | 6.21 | 16.3 | 8.50 | 0.51 | 0.53 |
| | Dehydrated | 2.3 | 23.0 | 5.76 | 15.9 | 8.76 | 0.49 | 0.50 |
| II | Freeze-dried | 3.7 | 25.2 | 5.27 | 19.8 | 12.65 | 0.62 | 0.61 |
| | Dehydrated | 3.1 | 26.3 | 5.04 | 20.3 | 10.05 | 0.54 | 0.57 |
| II | Freeze-dried | 5.4 | 25.5 | 5.92 | 20.2 | 10.16 | 0.54 | 0.57 |
| | Dehydrated | 2.0 | 25.8 | 5.02 | 20.8 | 10.88 | 0.44 | 0.46 |
| III | Freeze-dried | 7.0 | 24.3 | 4.82 | 17.9 | 12.94 | 0.34 | 0.38 |
| | Dehydrated | 2.4 | 24.6 | 4.50 | 18.5 | 12.70 | 0.36 | 0.41 |
| III | Freeze-dried | 6.4 | 25.0 | 4.47 | 18.4 | 10.90 | 0.36 | 0.41 |
| | Dehydrated | 3.4 | 24.2 | 4.51 | 20.4 | 11.20 | 0.31 | 0.41 |
| III | Freeze-dried | 7.6 | 25.5 | 5.16 | 21.0 | 11.88 | 0.36 | 0.40 |
| | Dehydrated | 4.5 | 24.1 | 4.70 | 22.4 | 11.10 | 0.39 | 0.41 |

[a] Moisture-free basis.

Table III. Stability of Amino Acids During Turf Grass Dehydration (g of Amino Acid/16 g Nitrogen)

| Fan speed, rpm | | 2100 | 2100 | 1800 |
|---|---|---|---|---|
| Outlet temp of dryer, °F | Freeze-dried | 250 | 270 | 270 |
| Meal moisture, % | | 2.2 | 1.7 | 1.2 |
| Amino acid | | | | |
| Lysine | 6.18 | 6.07 | 6.08 | 5.77 |
| Histidine | 2.00 | 2.04 | 2.02 | 1.98 |
| Ammonia | 1.56 | 1.52 | 1.58 | 1.46 |
| Arginine | 5.81 | 5.70 | 5.85 | 5.50 |
| Aspartic acid | 8.74 | 9.11 | 9.17 | 8.69 |
| Threonine | 4.84 | 4.86 | 4.95 | 4.75 |
| Serine | 4.45 | 4.32 | 4.42 | 4.26 |
| Glutamic acid | 12.28 | 11.94 | 12.17 | 11.64 |
| Proline | 4.76 | 4.63 | 4.73 | 4.51 |
| Glycine | 5.66 | 5.48 | 5.63 | 5.33 |
| Alanine | 7.47 | 7.23 | 7.45 | 7.06 |
| Valine | 6.70 | 6.36 | 6.61 | 6.16 |
| Isoleucine | 5.06 | 4.90 | 5.07 | 4.74 |
| Leucine | 8.76 | 8.45 | 8.65 | 8.13 |
| Tyrosine | 3.52 | 3.43 | 3.43 | 3.38 |
| Phenylalanine | 5.76 | 5.62 | 5.69 | 5.44 |
| Methionine | 2.17 | 2.21 | 2.21 | 2.17 |
| Cystine | 1.51 | 1.57 | 1.60 | 1.57 |
| Total nitrogen recovered, % | 88.04 | 87.48 | 88.18 | 83.66 |

essential in poultry feeds. The fiber contents of the dehydrated grass meals are considerably below levels that might cause growth inhibition in poultry when fed at 3–6% of the diet.

An earlier study at this laboratory (Livingston *et al.*, 1971) showed that considerable losses of the essential amino acids, lysine, cystine, and methionine occurred during alfalfa dehydration. These losses could be correlated with meal moisture and outlet temperature. Apparently due to the rapid rate at which the turf grass proceeded through the dryer, only a small loss of lysine occurred even in the lowest moisture meal. All of the other essential amino acids appeared to be stable under the dehydration conditions employed (Table III).

**Storage Stability.** Since much of the turf grass is grown over a short season, it may be necessary to store the meal for several months prior to incorporation into feeds. Previous studies have indicated that losses of carotene and xanthophyll during storage may be limited by addition of the antioxidant ethoxyquin to the meal prior to storage (Knowles *et al.*, 1968; Livingston *et al.*, 1955; Thompson, 1951). Therefore, samples of the dehydrated grass meals were stored at 90° F temperature with and without added ethoxyquin. The results are presented in Table IV.

The storage stability of the dehydrated and freeze-dried grass meals was considerably enhanced by the addition of ethoxyquin. However, due to the very high xanthophyll content of all the meals, ethoxyquin does not appear as effective as in dehydrated meals with lower initial xanthophyll. Knowles *et al.* (1968) previously pointed out that a considerable part of the early loss of xanthophyll in high epoxide xanthophyll containing meals is due to isomerization of the 5,6-epoxides to 5,8-epoxide xanthophylls with corresponding shifts in the spectra to shorter wavelengths; hence the 5,8-epoxides are not measured at 475 m$\mu$. Since mildly dried grass meals contain a higher percentage of the epoxide xanthophylls than do most dehydrated alfalfa meals, it would be important to employ an analysis that measured only the pigmenting nonepoxide xanthophylls when formulating poultry feeds utilizing mildly heated grass meals.

| Meal moisture, % | Sample | Initial mg/kg Carotene | Total xanthophyll | Non-epoxide xanthophyll | % Loss at 8 weeks Carotene | Total xanthophyll | Non-epoxide xanthophyll | % Loss at 12 weeks Carotene | Total xanthophyll | Non-epoxide xanthophyll |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.2 | Dehydrated meal | 513 | 811 | 705 | 41 | 22 | 20 | 46 | 27 | 26 |
| | Dehydrated meal + ethoxyquin[a] | | | | 15 | 15 | 10 | 34 | 19 | 12 |
| 2.2 | Dehydrated meal | 502 | 1137 | 746 | 46 | 40 | 30 | 49 | 46 | 37 |
| | Dehydrated meal + ethoxyquin[a] | | | | 39 | 24 | 13 | 43 | 28 | 21 |
| 2.4 | Dehydrated meal | 408 | 854 | 704 | 29 | 31 | 29 | 53 | 36 | 30 |
| | Dehydrated meal + ethoxyquin[a] | | | | 13 | 27 | 23 | 16 | 27 | 24 |
| 4.5 | Dehydrated meal | 398 | 1060 | 748 | 38 | 50 | 43 | 62 | 52 | 46 |
| | Dehydrated meal + ethoxyquin[a] | | | | 37 | 45 | 38 | 43 | 46 | 41 |
| | Freeze-dried | 516 | 1220 | 764 | 31 | 34 | 27 | 43 | 41 | 32 |
| | Freeze-dried + ethoxyquin[a] | | | | 36 | 31 | 19 | 37 | 33 | 22 |

Table IV. Storage Stability of Turf Grass Meals

[a] Added 0.015% ethoxyquin prior to storage.

The stability of carotene was nearly the same in the four meals not treated with ethoxyquin; however, xanthophyll stability varied. The most stable xanthophyll was that of the meal prepared to the lowest moisture level, while the least stable was that of the higher moisture meal. This would emphasize the importance of protecting the carotenoids in the meals by addition of an antioxidant or by storage in an inert atmosphere or at low temperature in order to ensure that the grass meals contain high levels of xanthophyll and other labile nutrients at the time of incorporation into a mixed feed.

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