Crambe Seed Processing. Improved Feed Meal by Soda Ash Treatment 1, 2

G. C. MUSTAKAS, L. D. KIRK, and E. L. GRIFFIN, JR.,
Northern Regional Research Laboratory, Peoria, Illinois
D. C. CLANTON, North Platte Station, University of Nebraska, North Platte, Nebraska

Abstract

Crambe seed, like rapeseed, is characterized by having thioglucosides and perhaps other anti-growth factors that diminish feed value and palatability. A soda ash cooking process was developed that modifies the thioglucosides in crambe meal and significantly improves its feeding value.

Destruction of the undesirable thioglucoside fraction of the meal was demonstrated, not only by paper chromatographic changes but also by negative results in tests which were based on conversion of the thioglucoside to thiooxazolidone. Sodium carbonate, added at a level of 1.4% (whole seed basis), destroys both the goitrin precursor, epi-progoitrin thioglucoside, and the ultraviolet-absorbing compounds in the meal, at least one of which is associated with bitterness. Animal-feeding tests demonstrated the improved palatability and nutritional quality of the meal.

Introduction

As a result of cooperative research between government and industry, Crambe abyssinica is emerging as a new industrial crop. Crambe, a member of the Cruciferae family, was selected as having excellent potential for development in a USDA-screening program for new oilseeds. During 1965 and 1966 approximately 1,500 acres were harvested and commercially processed.

Primary interest in crambe oil is based on its high erucic acid content. Rapeseed oil, also an erucic acid-bearing oil, is used in lubricants, greases, and other industrial applications. Because crambe oil has a higher erucic acid content than rapeseed oil, it should therefore have many potential uses (10). Crambe oil has proved to be a superior mold-release agent in the continuous casting of steel, and a strong demand for the oil is expected for this application alone.

One of the major problems with crambe is the feeding quality of the raw meal, or of untreated meal toasted like soybean meal, so that processing economics are adversely affected by the low value of this by-product. The untreated meal, whether raw or heated, is not palatable to animals and contains thioglucosides which need to be removed or destroyed for non-ruminants (4,12). In addition, sinapine, a bitter substance, and one other fluorescent compound are present in the untreated meal and may be related to a palatability problem noted in the feeding of ruminants.

Heat treatment, as employed in the processing of oilseeds, only partially destroys thioglucosides and does not make the meal palatable to cattle (3). Ammonia treatment of crambe meal, reported previously by Kirk et al. (5), somewhat improved the acceptability and usefulness of crambe meals. Unfortunately the degree of acceptability in preliminary tests with mature cattle was not duplicated in long-term feeding of calves (3).

This paper reports the use of a soda ash (sodium carbonate) process that deactivates unpalatable and growth-inhibitory factors in untreated crambe meal. This treatment was used commercially for the first time in the fall of 1965.

Experimental Section

Materials

Crambe seed used in this study was grown by private contract in 1964 in cooperation with the Crops Research Division, ARS, USDA. Analyses for whole seed, dehulled (periearp removed) seed, and dehulled prepress solvent-extracted meal are given in Table I.

Methods

Total thioglucoside was determined by the sulfate method of McElhee (7); epi-progoitrin thioglucoside, the major thioglucoside, was measured by enzymatic conversion to thiooxazolidone, as illustrated in Fig. 1. For this determination, a modified Wetter procedure (12) at pH 7.0 was used, which measured both free and enzymically produced thiooxazolidone.

In an alternative chromatographic procedure, thioglucosides were isolated by a hot-water extraction of crambe meals; the extracts were then chromatographed on paper by the descending technique discussed previously by Kirk et al. (5). Fluorescent spots were observed by exposure of the chromatogram to a "long-wave" ultraviolet lamp before spraying with silver nitrate was done.

Sinapine was determined by the method of Tzagoloff (9) with the modifications suggested by Austin et al. (2). Crude fat, moisture, ash, and protein analyses were done according to A.O.C.S. official methods (1).

Equipment

The seed was cracked on 6-in. diameter rolls with 10 corrugations per inch. The flaking rolls were smooth-faced and 12 in. in diameter. Dehulling equipment consisted of a shaker screen with provision for aspiration at the feed and discharge ends.

### Table I

<table>
<thead>
<tr>
<th>Assay</th>
<th>Whole Seed</th>
<th>Dehulled Seed</th>
<th>Dehulled Prepress</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Moisture</td>
<td>6.8</td>
<td>3.9</td>
<td>7.4</td>
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<tr>
<td>Crude fat</td>
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<td>47.0</td>
<td>1.0</td>
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<tr>
<td>Protein</td>
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<td>21.9</td>
<td>43.0</td>
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<tr>
<td>Crude fiber</td>
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<td>2.8</td>
<td>6.1</td>
</tr>
<tr>
<td>Ash</td>
<td>5.0</td>
<td>4.2</td>
<td>7.8</td>
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<tr>
<td>NFE</td>
<td>22.2</td>
<td>20.2</td>
<td>25.7</td>
</tr>
</tbody>
</table>

1 This paper was presented in part at the A.O.C.S. Meeting, Philadelphia, October 1966.
2 Journal Series, Nebraska Agricultural Experiment Station.
3 N. Util. Res. Dev. Div., ARS, USDA.
Solvent extraction was carried out continuously in a 20-stage counter-current Kennedy extractor or batchwise in a steam-jacketed, 50-gal tank equipped with a screen bottom.

Prepressing was conducted in a continuous screw-press, manufactured by Fuji Bunka Company Ltd., Tokyo, Japan. A two-stage, jacketed paddle conveyor served as a preconditioner for the screw press.

Equipment used for atmospheric cooking was a 1 cu ft ribbon blender (Fig. 2) or a 10 cu ft ribbon blender for the larger-scale experiments. Both units were steam-jacketed, had double-ribbon agitators, were provided with steam sparge systems, and were vented through condensers and receiver tanks.

Procedure

Two methods of cooking crambe with sodium carbonate were evaluated (Fig. 3 and 4): One was conducted on full-fat crambe; the other, on defatted crambe meal. The two approaches were selected as those which most closely simulated oilseed processes now used commercially.

Procedure A. In sodium carbonate cooking of full-fat meals, whole seed was cracked on corrugated rolls, and hulls (pericarp) were removed by air aspiration. This step was bypassed when no dehulling was done. The meats were then flaked and charged to the batch cooker, and carbonate was added to the mixture. The charge was then preheated to 180°F, moistened, steamed, dried, and discharged from the cooker. Fig. 3 shows a time/temperature profile of the cooking operation. After cooling, the meal was extracted with hexane at 140°F and desolventized by exposure to air.

Procedure B. In sodium carbonate cooking of defatted meals, whole seed was cracked and dehulled as in procedure A. The dehulled meats were then heated to 200°F in a two-stage, jacketed screw conveyor and fed to a screw press to reduce the residual oil content to approximately 20%. The remaining oil was hexane-extracted by either a batch process or by continuous extraction in a Kennedy countercurrent extractor. The defatted meal, containing 0.5–1% residual oil, was then cooked with sodium carbonate by the same method used in procedure A.

Heat-Treated Control Meals. Control meals were prepared for each procedure, A and B, by duplicating the heat-processing treatment but eliminating the addition of soda ash.

Results and Discussion

Processing data for a series of 11 runs are given in Table II.

Destruction of Thioglucoside

Crambe contains relatively large amounts of thioglucosides of which epi-progoitrin is the major one

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Fig. 1. Enzymatic hydrolysis of epiprogoitrin.

Fig. 2. Ribbon blender-cooker for soda ash treatment of crambe seed.

Fig. 3. Procedure A: sodium carbonate cooking of full-fat crambe meal.

Fig. 4. Procedure B: sodium carbonate cooking of crambe meal defatted by prepress extraction.