Utilization and Agronomic Studies of Cow Cockle (*Saponaria vaccaria*)[1]

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Saponaria vaccaria, L., cow cockle, a member of the Caryophyllaceae, is a weed commonly infesting cereal fields in many areas of the world. It is most common in the grain-producing sections of the northwestern states and western Canada. Although it usually does not persist, it may appear in other areas where western grains are fed.

Cow cockle seed was examined in a screening program for high oil-producing seeds, and, since it was too low in oil, it was discarded as a potential oil crop. The seed was observed to contain a rather high concentration of starch; this was confirmed by a fermentation test. These observations, together with the fairly large seed size, plant vigor, acceptable height, and apparent abundant seed production as a weed, suggested that this species might have potential as a crop. It was decided to investigate in more detail its agronomic characteristics and the chemical composition of the seed. This paper deals with these preliminary studies.

Materials and Methods

Three sources of cow cockle seed were available for these studies: 58-8140, an indigenous collection from Bozeman, Montana; 59-1, an indigenous collection from Moccasin, Montana; and 58-8158, a separation from P. I. 180264 mustard seed from Abu Road, Sirohi, India.

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These three accessions were compared in 1960 plantings at five dryland and four irrigated sites in Montana. These plantings were made as single 10-ft rows.

Subsequent plantings in 1962 and 1963 at the nine testing sites were made in four replications of four row plots, rows spaced 1 ft apart, with eight ft of each of the two center rows harvested for yield. All plantings in 1962 and 1963 were with the 58-8158 strain of cow cockle at a rate of 15 lb per acre. The data reported were taken from larger tests of 11 entries grown each year. Nitrogen was determined on the whole seed received from each source and is reported as percent protein (N x 6.25). Nitrogen determinations were made on a composite of replications I and II and a composite of replications III and IV.

A composite of 1962 and 1963 seed from all locations was used for milling and subsequent determinations.

Flour was prepared by milling the seed on a Brabender Quadromat Jr. mill and sifting on a U. S. standard Sieve No. 100. This sieve has a 149 micron opening. Material that passed through the sieve was considered flour, and material staying on top of the sieve was considered bran. No tempering was used, since preliminary milling results indicated no appreciable advantage.

Starch was prepared from the flour by the use of the alkali process described by Dimler (2). A Brabender viscosity curve was run on the starch at a concentration of 8 g/100 ml of water, using the procedure described by Mazurs et al. (3)

Seed and flour fractions were analyzed for ash, fat, fiber, protein, and starch by usual methods (1), ash, 22.0010; fat, 22.033; crude fiber, 22.040; protein, 2.036; and starch 22.043.

Results

Chemical analysis of cow cockle seed and milling fractions are reported in Table 1.

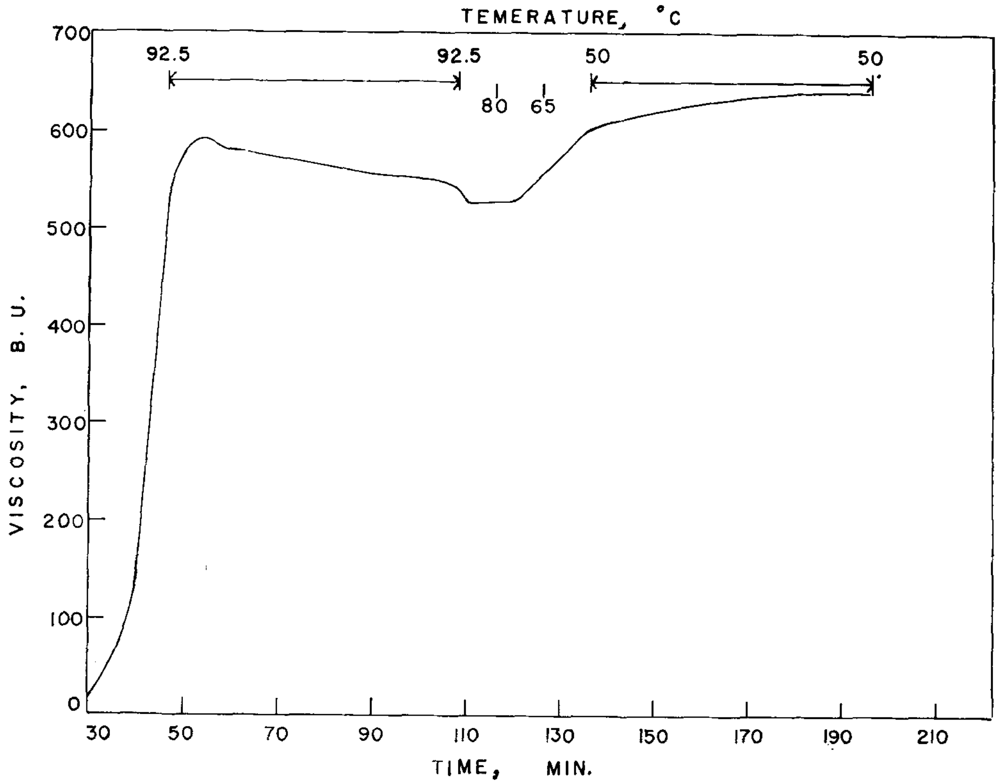

Fig. 1. Brabender viscosity curve for cow cockle starch at a concentration of 8g/100 ml.

The composition suggests that cow cockle seed might be a good source of starch. It appears to contain also an appreciable amount of material which is carbohydrate in nature, but is not starch. This material is probably hydrolyzed by conditions present during the determination of crude fiber content. An examination of fractions show that, although there were improvements in both starch content and elimination of fiber from the flour fraction, the flour is still very high in ash.

With the limited amount of seed available, satisfactory conditions for milling were impossible, since the best flour yields were only 25%. Although this would suggest the alkali process to be uneconomical, the ease with which it could be carried out suggested its use for obtaining enough starch for preliminary investigations.

The alkali process involves the removal of the protein by solution in dilute alkali. Since each particular protein has its own solubility characteristics, a cow cockle solubility study

TABLE 1

Chemical Analysis of Cow Cockle Seed, Flour and Bran (Dry Basis)

Fraction	Ash	Crude fiber	Fat	Protein	Starch	Nitrogen free extract
Whole seed	2.87	5.57	3.85	12.37	64.2	75.3
Bran	2.90	8.62	3.42	12.28	63.9	72.8
Flour	2.45	2.17	4.10	12.87	67.1	78.4

TABLE 2
PROTEIN EXTRACTION OF COW COCKLE FLOUR WITH SODIUM HYDROXIDE OF VARIOUS NORMALITIES

	Normality						
	0.020	0.025	0.030	0.035	0.040	0.045	0.050
pH	9.40	9.97	10.41	10.67	10.87	11.03	11.10
% Protein extracted	93.0	96.4	96.9	97.7	98.8	99.3	100.

was made and is reported in Table 2.

Cow cockle contains a strong buffer system, since it takes nearly twice as much alkali to reach a pH of 11 as does barley. The same observation was made in our laboratories in the extraction of mustard flour. The high alkali requirement is undesirable because of danger of gelatinizing the starch and high cost of operation.

The protein extracted by this process is recovered by adjustment of pH and centrifuging. Results of this study on cow cockle flour are reported in Table 3.

It is evident that rather poor recoveries of solubilized protein were obtained.

A small amount of starch was obtained by this process. An analysis of this starch indicated that it contained 0.30% ash, 0.20% fat, 0.50% protein, and 98.2% starch. Microscopic examination indicated it to be made up of very small spherical granules approximately two μ in diameter.

Since limited amounts of starch were available, a Brabender curve at a concentration of 8 g/100 ml of water was run to characterize this starch. This information is reported in Fig. 1.

The Brabender curve shows cow cockle starch to have a high peak viscosity, to be very stable at cooking temperatures, and to show little increased viscosity on cooling. This behavior is somewhat unusual and suggests that the starch might have unique commercial applications.

An evaluation of the worth of the above findings is in part dependent upon whether or not cow cockle could economically be adapted to cultivation.

Results of agronomic trials in 1960 with sources of cow cockle are presented in Table 4.

The three cow cockle sources produced under similar conditions varied in height, percent stand established, flowering and maturation dates, and weight per 100 seed. In April, 1962, two and four year old seed of strain 58-8158 germinated 99 and 98%, respectively. Further studies of germination characteristics of this species are in progress. Strain 59-1 exhibited a tendency for plants to break off at ground level when mature. Strain 58-8140 was several inches taller than the other two strains. Strain 58-8158 was selected for further studies because of its ability to establish stands.

Unitan barley and 58-8158 cow cockle were compared for yield and protein content of seed in trials conducted throughout Montana (see Table 5).

Production was 40% that of barley, ranging from 21 to 71% in successful trials. There appears to be no trend of relationship of the relative yields of barley and cow cockle to general growing conditions as expressed by the yield of barley. Cow cockle had about the same protein content as the barley variety Unitan.

The agronomic observations obtained on

TABLE 3
PRECIPITATION OF COW COCKLE PROTEIN WITH ACID

Percent Protein Precipitated at Various pH Levels Developed with HCl						
pH	3.3	4.4	4.7	5.3	5.9	6.8
Percent precipitated	72.8	73.3	74.7	71.7	64.8	5.1

TABLE 4

AGRONOMIC DATA OBTAINED ON THREE COW COCKLE STRAINS GROWN AT SEVERAL LOCATIONS IN SINGLE 10-FT. ROWS IN MONTANA IN 1960

Character measured	No. of locations average	Strain number 59-1	58-8140	58-8158
Dryland yield, lbs./acre	3	218	82	1155
Irrigated yield, lbs./acre	4	500	173	1082
Percent stand	4	21	3	61
Date of first flowering	4	July 11	July 8	July 4
Date in full flower	1	July 26	July 20	July 18
Date mature	2	Aug. 10	Aug. 4	July 30
Weight per 100 seed, g	5	.62	.70	.59
% protein, dryland	4			13.9
% protein, irrigated	4			13.7

TABLE 5

YIELD AND PROTEIN CONTENT OF BARLEY AND COW COCKLE GROWN IN QUADRUPLICATE FOUR ROW PLOTS IN MONTANA INTRASTATE NURSERIES IN 1962 AND 1963

				lb. per acre			% protein in seed	
Year	Location	Condition	Date planted	Unitan barley	58-8158 Cow cockle	Cow cockle as % of barley	Unitan barley	58-8158 Cow cockle
1963	Corvallis	irrigated	May 16	6144	1440	23	12.2	14.0
1963	Sidney	irrigated	May 6	4731	974	21	10.8	12.6
1962	Huntley	irrigated	May 4	4388	1573	36	10.0	12.1
1962	Bozeman	irrigated	May 11	4138	2930	71	13.4	12.2
1962	Sidney	irrigated	May 9	4064	1089	27	11.6	12.6
1962	Creston	irrigated	May 3	3928	2028	52	------	9.5***
1962	Creston	dryland	May 3	3724	1816	49	------	13.0***
1962	Sidney	dryland	May 9	3709	491*	13	14.0	13.2
1963	Sidney	dryland	May 6	3251	584*	18	12.6	13.4
1963	Bozeman	irrigated	May 22	3228	1814	56	13.6	13.4
1963	Huntley	irrigated	May 27	2697	1593	59	12.8	14.3
1963	Huntley	dryland	May 27	2059	1149	56	13.0	13.8
1962	Moccasin	dryland	May 24	1929	1149	60	11.6	11.2
1963	Huntley	dryland	May 4	1791	1004	56	14.5	12.2
1962	Havre	dryland	------------	1566	860	55	12.6	12.4
1963	Moccasin	dryland	May 16	1412	576	41	------	12.2***
1963	Havre	dryland	Apr. 30	128	304	238	15.7	14.2
	Average			3111	1257	40**	12.7	13.0

* Shattering before harvest ** Weighted average *** Omitted from average.

[1] All yield differences are significant at the 1% probability level.

TABLE 6

AGRONOMIC DATA OBTAINED ON COW COCKLE, STRAIN 58-8158 AND UNITAN BARLEY GROWN IN INTERSTATE TRIALS IN MONTANA IN 1962 AND 1963

Character measured	No. of station-years averaged	Unitan barley	58-8158 Cow cockle
Date flowered	9	July 1	July 6
Date mature	5	Aug 12	Aug 10
Height at maturity, inches	2	32	19
Test weight—lbs. per bushel	5	46.5	58.0

these trial plantings are summarized in Table 6.

Cow cockle is somewhat later to flower than Unitan barley but both mature at about the same time. Height of this cow cockle genotype would be borderline for combine harvest. However, the fact that the flowering branches are intertwined should permit the crop to be directly harvested with a combine to a minimum height of about 16 inches. When barley had a test weight of 46.5 lbs. per bushel, cow cockle had a test weight of 58.0 lbs. per bushel.

Conclusions

Preliminary work on cow cockle seed suggests that this species may have an unusual new starch which could have certain special applications. Inability to produce good yields of flour and difficulty encountered in using Dimler's process suggests that some type of modified wet-milling technique should be used on this starch source which might permit recovery of adequate amounts of starch so that its properties could be thoroughly investigated. Investigations on milling and chemical properties are continuing in our laboratories.

Preliminary agronomic evaluations suggest that this species could be handled with current farm equipment. With essentially no studies on adaptation, management or development of superior genotypes, it is surprising that this plant produced 40% of the yield of the best adapted Montana barley variety and up to 71% in one instance. Evaluation of three sources indicate that variability for plant height, germination, seed size, and flowering dates exist. This indicates that even among these three genotypes sufficient variation exists to provide some genotype improvement through a crossing and selection program.

Literature Cited

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