# *Composition and Feeding Value Of Almond Hulls and Hull-Shell Meal*

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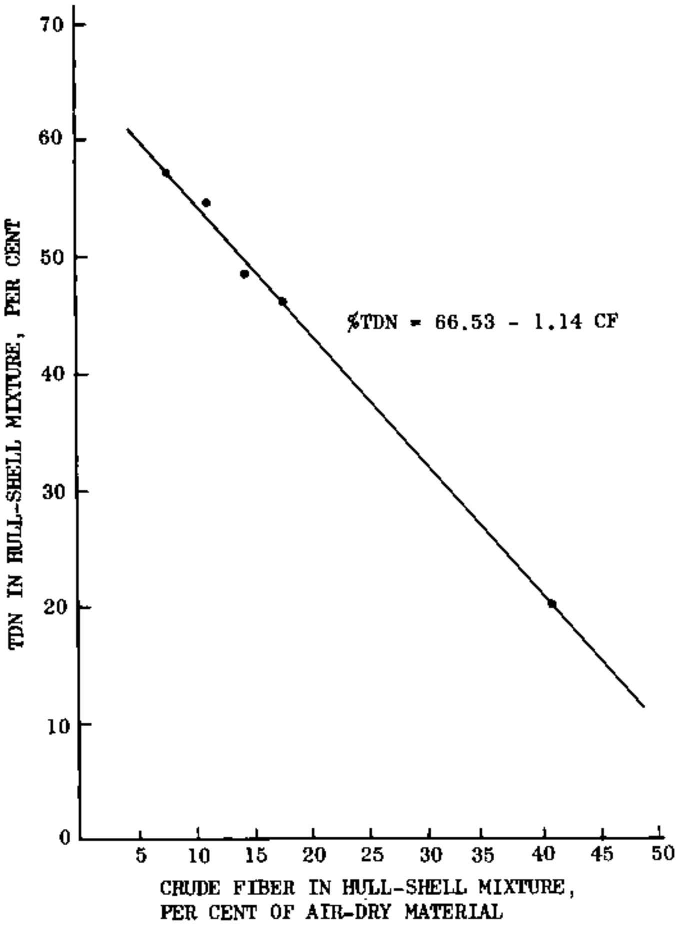
As recently as 1948, almond hulls were considered of little or no value, and most of them were burned or otherwise destroyed. Then as a result of work by University of California researchers (1948–1951), hulls were found to have an energy value 65 to 90% of barley.

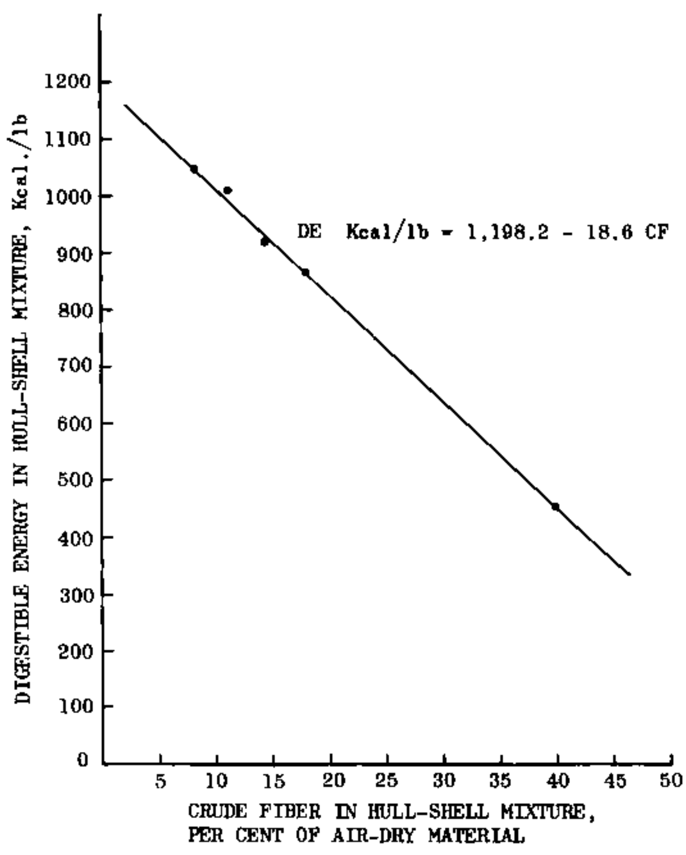
Methods of processing almonds have recently been changing from rough hulling (hulls alone removed as the by-product) to shelling (hulls and shells removed together as the by-product). This change resulted in the new feed by-product of almond hull and shell meal. Immediately, questions arose on the value of almond hull and shell meal as compared with pure hulls.

In 1963, almond growers, processors, marketing agencies and cattle feeders joined in presenting a research grant to the Department of Animal Husbandry,

GRAPH 1. REGRESSION OF TOTAL DIGESTIBLE NUTRIENTS CONTENT OF ALMOND-HULL-SHELL MEAL ON ITS CRUDE FIBER CONCENTRATION.




GRAPH 2. REGRESSION OF DIGESTIBLE ENERGY CONTENT OF ALMOND-HULL-SHELL MEAL ON ITS CRUDE FIBER CONCENTRATION.



**More than $1,000,000 worth of almond hulls have been marketed annually by California almond growers in recent years. This by-product of the almond industry is used mainly by livestock producers in beef cattle feeding operations. New methods of processing almonds have resulted in a feed by-product now consisting of almond hull and shell mixtures. Studies reported in this article indicate that hull-shell meal supplies little or no protein and is also a poor source of phosphorus and fat. However, the hull-shell mixtures are high in nitrogen-free extract, sugars and potassium. The money value of Nonpareil variety almond hull-shell meal containing an average of 18% fiber is about 58% that of barley.**

Davis, for additional work on the value of these almond by-products. Nonpareil variety was chosen for digestion trial work, since it comprises almost half the almond acreage in California. The objectives of the experiment were: first, to evaluate hull-shell mixtures that included increasing amounts of shells; and second, to find a method of predicting nutritive values of hull-shell mixtures, including any amount of shell.

### Five rations

Five experimental rations were fed to five mature wethers in conventional digestion trials—designed in such a way that each wether received each of the five rations during the course of the trials. The rations tested included:

(A) Alfalfa hay pellets; (B) Equal parts of alfalfa hay and almond hulls; (C) Equal parts of alfalfa hay and almond hulls plus sufficient almond shells to equal 10% of the hull-shell mixture; (D) Equal parts of alfalfa hay and almond hulls plus sufficient almond shells to equal 20% of the hull-shell mixture; (E) Equal parts of alfalfa hay and almond hulls plus sufficient almond shell to equal 30% of the hull-shell mixture.

All rations were ground and pelleted, to prevent selection of ingredients. Each one of the digestion trials consisted of a two-week period during which feed intake was maintained constant. During the last seven days, quantitative collection of all fecal excretion was made. Feed and feces were subjected to laboratory anlysis to determine the digestibility of the rations.

### Results

Total Digestible Nutrients (TDN) and Digestible Energy (DE) were determined for all experimental rations and nutritive values of pure hulls, hull-shell mixtures and pure shells were calculated. Nutritive values for almond hull, hull-shell mixtures and shells of the Nonpareil variety are listed below, with figures reported on air-dry matter basis:

| Shells in the hull-shell meal Per cent | TDN Mean per cent | Mean digestible energy Kcal/lb |
|---|---|---|
| 0 | 57.7 | 1,047 |
| 10 | 54.9 | 1,016 |
| 20 | 48.5 | 908 |
| 30 | 46.6 | 866 |
| 100 | 20.7 | 445 |
| Standard error of the means* | ± 0.6 | ± 18 |

* Includes all means except the ones for pure shells whose standard errors are ± 2.7% units for TDN and ± 61 Kcal/lb for DE.

### Crude fiber

Since shells are considerably higher in crude fiber (CF) than hulls, the possibility exists that this measurement could be used to predict the nutritive value of any hull-shell meal of the Nonpareil variety. Analysis of the correlation between CF and TDN and between CF and DE showed a highly significant correlation coefficient ($r > 0.9$). Regression analysis demonstrated that prediction of nutritive value of almond hull-shell meal in terms of TDN or DE was both possible and reasonably accurate.

The graphs show the rate of decrease in nutritive value as the crude fiber increases. The regression equations indicate a drop of 1.14% in TDN or 18.6 Kcal/lb for each 1% increase in CF of the air-dry meal, and that this drop in nutritive value is constant throughout a range of about 8 to 40% CF.

With the use of either equation and a reference feed, the monetary value of a sample of almond hull-shell meal can be estimated. Barley is a common energy reference feed used for such purpose, although any other feed can be used. The monetary value of the hull-shell meal was obtained as follows:

(1) from a crude fiber analysis of the hull-shell meal in question, TDN can be predicted by the use of the formula developed in this work. As shown later in this report Nonpareil hull-shell meal will average about 18.3% CF. Thus, TDN $= 66.53 - 1.14 \times 18.3 = 45.7\%$; (2) divide the TDN of the hull-shell meal, as predicted by the equation, by the TDN of the reference feed. In the case of barley, its TDN value is 78.8, thus: $44.0 \div 78.8 = .558$. This figure means that the hull-shell meal in question has 55.8% of the value of barley; (3) multiply the current price of barley by the factor found in step 2. If barley is selling at $50.00 per ton, the monetary value of hull-shell meal (18.3% CF) would be $.58 \times 50.00 = \$29.00$ per ton. The DE equation can be used by merely using the DE of the reference feed instead of its TDN value.

### No protein

From table 1, it can be seen that in this experiment the protein intake from hull-shell mixtures was very low as compared with that from alfalfa hay. The apparent digestible protein was less than zero in the hull-shell meals. Correction for Metabolic Fecal Nitrogen, using a value of 0.45 g of nitrogen per 100 g of dry matter intake, did not show that there was any contribution to the absorbed protein from the hull-shell mixtures. Therefore, when using almond hull-shell meal as a ration ingredient, it should be given a digestible protein value of zero. In other words, this product has nutritive value mainly as an energy source.

Because almond hull-shell mixtures furnish no digestible protein, this product cannot be compared directly to barley on a TDN basis alone. The lack of protein in the hull-shell mixture must be compensated for by adding a protein-rich feed. With cottonseed meal priced at approximately $65 per ton, a deduction of about $3.25 per ton would have to be made from the value of hull-shell meal. Therefore, the hull-shell meal in the example would be worth $29.00 minus $3.25 or $25.75 per ton.

### Variety research

In addition to digestibility research on Nonpareil hulls and shells, work was also initiated on the physical and chemical makeup of the six most widely used almond varieties in the state. Thirty-two samples of these varieties were collected for analysis during the 1962–63–64 seasons.

Considerable variation was found between varieties in percentage of hull, ratio of shell to hull and in chemical composition. Variation was found within the same variety from year to year, and orchard to orchard. However, several generalizations can be made about varietal, physical and chemical characteristics: (1) physical and chemical composition of hulls and shells from dryland and irrigated orchards is similar; (2) there is a greater percentage of fleshy outer hull in the soft-shelled varieties (Nonpareil and IXL) than in hard-shelled almonds (Mission, Peerless, Drake) with the semi-soft shelled Ne Plus Ultra being intermediate; (3) there is a smaller percentage of shell in the hull-shell mixture of soft-shelled varieties; (4) almond hulls and hull and shell meal are poor sources of protein, calcium, phosphorus and fat, but hulls contain a high percentage of nitrogen-free extract (NFE), sugars and considerable potassium; and (5) the hulls and shells of soft-shelled varieties have a tendency toward less fiber and lignin content than hard shells.

### Other factors

The feeding value of hulls can be lowered by contamination with other materials such as twigs and sticks. Every effort should be made to keep the twig and stick content of almond hulls and almond hull and shell meal as low as possible, because these materials have a high (32.5%) fiber and 32.83% lignin content and are very undigestible.

The usual moisture content of almond hulls is about 10%, under air-dry conditions. Each 1% increase of moisture above 10% decreases the value of almond hulls approximately 1%.

An unusually high ash content in almond hulls or almond hull and shell mix probably indicates the presence of dirt, which has no value from a feed standpoint. The highest ash content in the samples analyzed was 8.8% on an oven-dry basis, or 7.9% on an air-dry (10% moisture) basis.

An average crude fiber content for hull and shell mix of the six varieties tested can be predicted from the hull-shell ratios and average chemical analysis of hulls and shells. Actual analysis may be higher or lower due to deviation from average values, but the predicted crude fiber percentage of shell-hull mix (10% moisture) would be 18.3% for the Nonpareil variety, 20.5% for IXL, 22.6% for Ne Plus Ultra, 26.6% for Drake, 28.9% for Mission, and 30.8% for Peerless.

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TABLE 1, DIGESTIBILITY ESTIMATES OF PROTEIN IN EXPERIMENTAL RATIONS

| | Ration | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| **Crude protein, daily intake (grams):** | | | | | |
| from total ration | 258.8 | 161.9 | 153.1 | 146.9 | 138.8 |
| from alfalfa hay | 258.8 | 130.0 | 125.0 | 117.5 | 104.4 |
| from hull-shell meal | 000.0 | 31.9 | 28.1 | 29.4 | 34.4 |
| **Apparently digestible protein intake (grams):** | | | | | |
| from whole ration | 189 | 71 | 69 | 64 | 58 |
| from alfalfa | 189 | 95 | 91 | 86 | 76 |
| from hull-shell meal | 000 | less than zero | | | |
| **Coeffs. of apparently digestible protein** | 73.0 | 43.9 | 45.0 | 43.9 | 42.1 |
| **True digestible protein intake* (grams):** | | | | | |
| from whole ration | 225 | 108 | 106 | 101 | 94 |
| from alfalfa hay | 225 | 113 | 109 | 102 | 91 |
| from hull-shell meal | 000 | essentially zero | | | |
| **Coeffs. of true digestible protein** | 86.9 | 66.4 | 69.0 | 69.0 | 68.0 |

* 0.45 g nitrogen per 100 g of dry matter intake was used as an estimate of metabolic fecal nitrogen.



# BARK GRA

## *at high*

C. J. ALLEY

CLEFT GRAFTING is the most common method presently used to graft grapevines. It is generally done in February or March when the sap begins to flow. It is performed just below ground level on vines growing on their own roots or slightly above ground level on resistant rootstocks. This method of grafting works well with vines having straight-grained wood. However, many vines have a twisted grain which makes grafting more difficult.

The entire graft is then preferably covered with a large wide mound of loose soil to a depth of 1 to 3 inches above the top of the scions. The scion shoots are allowed to grow through this mound, and the most vigorous and best located shoot is trained up the stake.

Green grafting is about the only type of grafting done above ground level and higher than 6 inches. Even then, it is confined to young vines of small diameter trunks and requires certain cultural conditions for success.

COMPARISON OF BARK GRAFTING GRAPEVINES AT HIGH AND LOW LEVELS

| Date grafted | Per cent scions growing per vine | | Brush weight/vine (lbs) | |
|---|---|---|---|---|
| | High level | Low level | High level | Low level |
| 5-24-63 | 65 | 80 | 2.4 | 4.0 |
| 6-7-63 | 65 | 30 | 1.1 | 0.3 |
| 6-22-63 | 85 | 1 | 0.9 | 0.1 |
| 7-5-63 | 60 | 40 | 0.2 | 0.1 |
| 7-19-63 | 100 | .. | 0.5 | .. |
| 8-2-63 | 80 | 30 | 0.3 | 0.1 |
| 8-16-63 | 80 | 35 | 0.1 | 0.0 |
| 8-30-63 | 65 | 65 | 0.0 | 0.1 |

Aerial types of bark grafting, using dormant scionwood, have been commonly used for deciduous fruit trees, but not for grapevines. The bark grafting used on the grapevines in this report was a type of bark graft used for walnut trees