

AGRINTER-AGRIS

**ANNOTATED BIBLIOGRAPHY**

**UTILIZATION  
OF COFFEE BY-PRODUCTS  
IN AGRICULTURE, INDUSTRY  
AND ANIMAL FEEDING**

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## 1. INTRODUCTION

*Improvement of animal production implies the development of techniques and procedures which must be intimately related to the environment and available natural resources. Therefore, in addition to the grassland resource, it is necessary for Tropical American countries to find adequate means for the utilization of other resources which are wasted at the present time. The use of other natural resources would permit a more efficient utilization of pastures and a solution, at least partially, of the problems resulting from seasonal scarcity of grasses.*

*Coffee pulp and other coffee by-products are examples of resources generally wasted. The interest among researchers, producers and developmental institutions of the coffee producing countries, in finding adequate systems for the utilization of these by-products is evident. This interest encompasses the use of coffee by-products in industrial activities (production of microbial protein, production of alcohol, extraction of caffeine, etc.), agriculture (as fertilizer, as mulching material, and as organic material for the improvement of soil physical nature), and their direct use in animal feeding.*

*The collection of abstracts in this Annotated Bibliography is as complete as was possible to gather, and has been compiled to impart to persons and institutions, working towards the development of coffee by-products utilization systems, the information that is usually not available in the libraries of our countries. It is sincerely hoped that this publication will be of assistance to feed manufacturers, investigators, professors, students, extension workers, farmers, industrialists and others who are contributing towards the development of effective animal production systems and an increase in the efficiency of utilization of natural resources.*

## **2. METHODOLOGY**

Most of the material contained in this publication is the result of research conducted in Tropical America; other papers consulted originated in Europe, Africa, Asia and the United States of America. A total of 86 references are included, covering the years 1917 through 1974.

In the process of preparing this publication, in some cases the original abstract was transcribed in its entirety; in other instances, the original abstract was modified in order to add objectivity. In most cases, the abstract was elaborated since the original article lacked one. With the exception of two or three papers which were unobtainable, all abstracted articles were read and studied. Fourteen references do not include the corresponding abstracts due to the impossibility of obtaining the original papers.

Most of the information was procured from the Library of the Inter-American Center for Agricultural Documentation and Information IICA-CIDIA, at Turrialba (reference books, journals, bibliographies, etc.).

An author index and a subject index are included at the end of this publication in order to assist the reader in locating specific information.

This publication is the result of a continuous information gathering effort starting in November 1973 and ending in May 1974. This task was conducted by the Tropical Animal Production Department of CATIE and was financed by the Inter-American Institute of Agricultural Sciences of the Organization of American States.

### 3. CHEMICAL COMPOSITION AND DIGESTIBILITY

#### 3.1

*Anonymous* ¿CAFE PARA BOVINOS? [Coffee for Cattle?]. *La Hacienda* 39(2): 84. 1944.

In this short communication it is reported that a sample of "coffee residues" (apparently coffee pulp) from Nicaragua was analyzed by the University of California. The composition was as follows (%): Dry matter 94.5, protein 13.0, crude fiber 19.7, N-free extract 50.1, and ash 9.0. Apparently, the ether extract level was 2.7% if all chemical components are supposed to add up to 94.5. It was also found that this material had good acceptability by cows although no complete feeding trials were conducted due to the small amount of coffee available. Finally, the report indicates an amount "somewhat less than 5%" of tannins and "around 0.5%" of caffeine.

#### 3.2

*Aruch, E.* I FONDI DI CAFFE NELL'ALIMENTAZIONE DEGLI ANIMALI. [Coffee Residues in Animal Nutrition]. *L'Italia Agricola* 55(10): 299-304. 1918.

Editor's note: The following abstract was obtained from the review by Barbera (abstract No. 11.2) and not from the original paper which was not available.

The nutritional value of spent coffee grounds as a feed ingredient was tested. In the feeding trials, steers, cows, horses, rabbits, chickens, geese and pigs were used. The chemical composition of the spent coffee grounds used in this experiment, was the following: 11.42% humidity; 12.45% ether extract; 11.5% crude protein; 22.47% starch; 2.03% ash; 14.81% nitrogen-free extract; and 25.30% fiber. In all trials the results were excellent, especially when the feed was very dry and finely ground. The animals with the best response were the cows; not only was the milk production increased by 5%, but its composition was also improved.

#### 3.3

*Bressani, R., Gómez Brenes, R. and Conde, R.* CAMBIOS DE LA COMPOSICION QUIMICA DEL GRANO Y DE LA PULPA DE CAFE DURANTE EL PROCESO DE TOSTACION, Y ACTIVIDAD BIOLÓGICA DE LA NIACINA DEL CAFE. [Changes in the Chemical Composition of Coffee Bean and Pulp during the Roasting Process, and Biological Activity of Niacin]. *Archivos Venezolanos de Nutrición* 12(1): 93-104. 1962.

#### 3.4

*Bressani, R., Jarquín, R., Estrada, E. and Gómez B, R.* COMPOSICION QUIMICA DE LA PULPA DE CAFE. [Chemical Composition of Coffee Pulp]. *ALPA (Latin American Association of Animal Production)* 6: 113-114. 1971.

As a result of the processing of the coffee berries, two by-products are recovered, the pulp and the parchment, but a third by-product, the mucilage, is not recoverable. The pulp represents between 45 and 65% of the weight of the dehydrated bean without pulp and mucilage; the parchment represents between 20 and 25% of the weight of the dried depulped bean. This work was carried out with the purpose of utilizing both of these by-products in animal nutrition. The fresh pulp samples contain approximately 82% humidity; 0.5% nitrogen; 0.5% ether extract; 4.0% crude fiber; 1.5% ash; and 11.5% nitrogen-free extract. On a dry basis, the chemical composition of coffee pulp is very similar to that of corn, except for the crude fiber and the ash, which are higher in the coffee pulp. The average content of calcium, phosphorus and iron is 520, 140 and 16 mg/100 g of dry coffee pulp, respectively. Of importance among the vitamins is the high niacin content, with an average value of 37 mg/100 g. The dry pulp contains about 2% caffeine and 3% polyphenols, substances that could interfere with its utilization. The data indicate that coffee pulp is a potential source of protein and carbohydrates; therefore, these compounds have been described on the basis of their content of sugars and aminoacids.

#### 3.5

*Bressani, R., Estrada, E. y Jarquín, R.* PULPA Y PERGAMINO DE CAFE. I. COMPOSICION QUIMICA Y CONTENIDO DE AMINOACIDOS DE LA PROTEINA DE LA PULPA. [Coffee Pulp and Parchment. I. Chemical Composition and Aminoacid content of the Protein in Pulp]. *Turrialba* 22(3): 299-304. 1972.

Coffee pulp and coffee hulls were analyzed for their proximate chemical composition and mineral content. The protein of coffee pulp was also analyzed for its content in essential and non-essential amino acids. Dehydrated coffee pulp contains protein concentrations comparable to those of most cereal grains although it presents more crude fiber and less crude fat. Ensilaged coffee pulp has a chemical composition similar to that of dehydrated pulp. The caffeine content of dehydrated pulp was found to decrease with time

of storage. The amino acid pattern of coffee pulp protein was found to be superior to that of cereal grain protein, particularly in those amino acids in which cereal protein is deficient. Lysine content was as high as that of soybean protein. Sulfur-containing aminoacids probably limit the quality of coffee pulp protein. Coffee hulls contain high levels of crude fiber, and small amounts of protein. These are also high in their calcium and potassium content. Both by-products are now being studied as components of ruminant rations.

### 3.6

*Martínez Nadal, N.G. COFFEE BY-PRODUCTS. THEIR CHEMICAL COMPOSITION AND POSSIBLE ECONOMIC USES. Coffee and Tea Industries and the Flavor Field 81(8): 9-10, 33-34. 1958.*

In this review article, the author considers the possible uses of coffee by-products based, partially, on work conducted by herself at the U.S. Experiment Station in Mayaguez, Puerto Rico. Coffee flowers give excellent perfume reminiscent of jasmine, cassia and mimosa. Coffee pulp can be converted into a compost to be used as a fertilizer. The mineral content of coffee pulp ash is as follows (%): Phosphoric acid 10.3; potassium 53.0; calcium 3.8; magnesium 7.6; sulphuric acid 3.3; chlorine 0.8; and others 21.2. Coffee pulp could also be dried and used as fuel or as cattle feed. Its chemical composition and digestibility coefficients reported in this article are cited elsewhere in this Annotated Bibliography. Also, from the literature reviewed appear the following data on composition (%): Moisture 42.7; volatile oils 0.11; waxes, fats and resins 1.18; raw fiber 27.45; tannins 8.56; sugars 9.46; minerals 3.77; and others 6.82. Coffee hulls have been tried as cattle feed but the low nutritional value as well as the hard, crusty appearance and sour taste make them most unattractive to animals. It is not possible to use coffee hulls as fertilizer or mulch due to their low decaying rate. It would appear that coffee hulls can be successfully used as a supporting medium in the processing of vinegar since they have better properties than other materials commonly used.

### 3.7

*Van Severen, M.L. and Carbonell, R. ESTUDIOS SOBRE DIGESTIBILIDAD DE LA PULPA DE CAFE Y DE LA HOJA DE BANANO. [Studies on the Digestibility of Coffee Pulp and Banana Leaves]. El Café de El Salvador 19(219): 1619-1624. 1949.*

Two digestibility trials were conducted, one with sundried ground coffee pulp and one with fresh

banana leaves. Five Anglo-Nubian crossbred goats were used. Coffee pulp was found low in protein digestibility (34%). Digestibility coefficients for the other nutrients were high: Nitrogen-free extract 76%; ether extract 98%; crude fiber 88%. Dry matter digestibility coefficient was 76%. Despite its low content of digestible proteins, coffee pulp can be considered as a good foodstuff for cattle due to its high crude fiber digestibility coefficient. The proximate analysis of coffee pulp indicated: Protein 9.0%, NFE 60.2% ether extract 1.7%, crude fiber 19.3%, and ash 9.8% .

### 3.8

*Varma, S.D., Kwatra, B., Ajit Singh and Yadav, I.S. UTILIZATION OF PROTEIN PRESENT IN COFFEE CAKE (RAT). Journal of Nutrition and Dietetics 5(2): 130-133. 1968.*

Coffee cake (an industrial waste) contained about 22% crude protein, 10% ether extract, 38% crude fiber, 26% N-free extract, 1.5% moisture and 2.5% ash. The protein N was highly digestible. The average digestibility was 89.9%. The absence of about half of the essential aminoacids is a limiting factor in its use as the sole source of protein.

See also abstracts 6.1, 6.4, 7.1, 7.2, 7.3, 8.15, 9.8 and 12.1.

## 4. FEEDING VALUE. POULTRY

### 4.1

*Bressani, R., Elias, L.G., Estrada, V.E. and Jarquín, R. VALOR NUTRITIVO DE PULPA DE CAFE EN MONOGASTRICOS. [Nutritive Value of Coffee Pulp in Monogastric Animals] Alpa (Latin American Association of Animal Production) 6:142-143. 1971.*

Preliminary results on young ruminants fed rations containing up to 30% coffee pulp indicated the possible presence in coffee pulp of unidentified compounds that have adverse effects. Studies on rats and chickens were started, with the purpose of identifying some of these compounds and to determine the effect of several processes on the

utilization of coffee pulp. These studies consisted in the evaluation of the effect of replacing corn, in a diet based on soybean and corn, with different levels of coffee pulp, either dehydrated or processed in various ways. The results revealed that as the amount of coffee pulp increased in the ration, the body weight of the animals decreased. Rations containing 30% pulp caused high mortality before the seventh day in rats and chickens, along with a variety of symptoms. Research data showed that none of the following processes eliminated the toxicity of coffee pulp: dry and wet cooking, extraction of the aqueous part, fermentation, and pulp extraction with organic solvents. It was interesting to find that the animal can become adapted to levels of up to 50% of coffee pulp, if the animal is fed diets containing progressively higher levels of pulp. It was also found that storage seems to reduce the toxicity. The possible toxic substances are caffeine and chlorogenic acid which, however, have not as yet been definitively identified.

#### 4.2

*Bressani, R., Estrada, E., Elias, L.G., Jarquin, R. and Urrutia de Valle, L. PULPA Y PERGAMINO DE CAFE. IV. EFECTO DE LA PULPA DE CAFE DESHIDRATADA EN LA DIETA DE RATAS Y POLLOS. [Coffee Pulp and Parchment. IV. Effect of dehydrated Coffee Pulp in the Diet of Rats and Chicks]. Turrialba 23(4): 403-409. 1973.*

Various studies using young and adult rats as well as young chickens were carried out to evaluate their tolerance to increasing levels of coffee pulp in their diets. The coffee pulp used was subjected to various physical, chemical or biological treatments to determine whether or not such treatments would increase its tolerance by the animal species utilized. Dehydrated and ground coffee pulp was added to a basal diet for rats and chicks in increasing levels: 10, 20, 30, 40 and 50 per cent, to replace an equal amount of ground corn in the diet. The results indicated that as the coffee pulp level increased in the diet, the average weight gain of the animals decreased. Likewise, feed intake also decreased. Diets containing 30 per cent coffee pulp or more caused a high mortality in less than 3 days in both young rats and chicks, with variable symptoms, but hemorrhage was always present. It was also evident that the adult rat was more resistant to coffee pulp than young rats, and that these can adapt themselves to relatively high levels of coffee pulp in the diet, when they are fed, progressively, diets with increasing levels of the by-product. The chick appears to be more sensitive than the young white rat. Results were also obtained which indicate that fermentation of coffee pulp before dehydration

partially destroys the factors responsible for the adverse effects observed, allowing better animal performance. Findings also revealed that prolonged storage of dehydrated coffee pulp decreased its caffeine content and induced a lower mortality in the rats.

#### 4.3

*Carew, L.B., Alvarez, H. and Marín, O.M. STUDIES WITH COFFEE OIL MEAL IN DIETS FOR GROWING CHICKS. Poultry Science 46(4): 930-935. 1967.*

Feeding of diets containing solvent extracted oil meal to chicks resulted in marked depressions in growth rate and feed intake, and increases in mortality. Feed intake and growth rate were progressively diminished with increasing dietary levels of coffee oil meal. Marked toxicity was observed only when the diet contained 10% or more of coffee oil meal. In comparison, dietary levels as low as 2.5% significantly reduce growth rate. Autoclaving of raw coffee oil meal resulted in small but significant improvements in growth and approximately 50% reductions in mortality, over untreated coffee oil meal. However, the nutritional quality of coffee oil meal was not improved sufficiently by heating for it to be considered a useful ingredient in diets for chicks. The results, coupled with the observation that mortality appeared related to hepatic and biliary lesions, may indicate that toxicity and growth reduction are manifestations of different substances in the meal. Neither high dietary levels of water soluble vitamins nor the use of glucose in place of corn as an energy source was of much benefit in improving the poor quality of diets containing coffee oil meal.

#### 4.4

*De Andrade, B.M., Penteadó, L.A. and Raimo, H.F. ACAO TOXICA DOS FARELOS DE TORTAS DE CAFE E DE AMENDOIM NAS AVES EM CRESCIMENTO. [The Toxic Effect of Coffee Oil Meal and Peanut Oil Meal on Growing Chicks] Boletim de Industria Animal (Brazil) 20:379-383. 1962.*

Two hundred unsexed New Hampshire chicks were used to test the toxic action of coffee oil meal and peanut oil meal. The results obtained were highly significant for the 5 and 10% levels of coffee oil by the F and t tests, at 1% level of probability. The results are presented as follows: The 5 and 10% levels of coffee oil meal in starter rations were highly toxic (high mortality, retarded growth, poor feathering and dull aspect of the chicks). The toxic action of coffee oil meal was related to the

levels used with 1% level not depressing the growth rate. The toxic action is characterized by a cumulative effect. The peanut oil meal used in the test depressed the growth rate and the efficiency of the ration.

#### 4.5

*De Andrade, B.M., Penteadó, L.A. and Raimo, H.F.* EFEITOS TOXICOS DOS FARELOS DE TORTAS DE CAFE E DE AMENDOIM SOBRE A POSTURA DAS AVES E ECLOSÃO DOS OVOS. [Toxic Effects of Coffee Oil Meal and Peanut Oil Meal on Egg Laying and Hatchability]. *Boletim de Industria Animal (Brazil)* 20: 385-390. 1962.

Sixty breeding hens (30 New Hampshire and 30 White Leghorns) were used to test the action of coffee oil meals in three levels, the peanut oil meal and penicillin mycelium on laying and hatchability, during 12 weeks. After 7 weeks, the 5 and 10% levels of coffee oil meals were delayed to test the reaction of the breeding hens, in relation to the results observed till that date. The results obtained were as follows: The coffee oil meal in the levels of 5 and 10% showed toxic action (drop in the laying and hatchability). The toxic action of coffee oil meal was related to the levels used, with 1% level not depressing the laying and hatchability during the test. The egg laying was not depressed by the use of peanut oil meal and its action on hatchability was not clearly showed, with highly variable results. The penicillin mycelium in the level used did not show depressive action on laying and hatchability. The results obtained with coffee oil meal (5% level or over) were highly positive, but more extensive tests on the peanut oil meal action are recommended.

#### 4.6

*Echavarría, G.* LA PULPA DE CAFE COMO ALIMENTO PARA EL GANADO. [Coffee Pulp as a Feed for Cattle]. *Revista Cafetera de Colombia* 8(115): 3310-3313. 1947.

In this article, a cattleman describes how sun-dried coffee pulp was gradually increased as an ingredient in a ration for dairy cows, reaching an apparent level of 30% in the concentrate. In addition, chopped green grass was available *ad libitum*. The author states that after one and a half years of usage of coffee pulp no detrimental effects on milk production were observed. On the contrary, milk production occasionally increased by 10 or 25%. The remaining sections were devoted to describing an article written by F. Choussy (see abstract 8.8 in this Annotated Bibliography).

#### 4.7

*Méndes, T. Teixeira and Torres, A.P.* A TORTA DE CAFE NA ALIMENTAÇÃO DAS AVES. [Coffee Cake in Poultry Nutrition]. *Revista de Agricultura (Piracicaba)* 36(2): 75-83. 1961.

The cake is a by-product obtained by oil and caffeine extraction from non marketable types of coffee beans. These investigations prove that coffee cake has a noxious action on the chickens' development increasing the mortality to a rate that dissuades its use as a poultry feed.

#### 4.8

*Scott, M.L.* COFFEE, TAPIOCA, COCONUT - BROILER PROTEIN SOURCES. *Broiler Industry* 30(10): 98-100. 1967.

See also abstract 12.4.

## 5. FEEDING VALUE. SWINE

#### 5.1

*Rosales, F.* USO DE LA PULPA DE CAFE DESHIDRATADA EN LA ALIMENTACION DE CERDOS. [The Use of Dehydrated Coffee Pulp in Swine Feeding] *Thesis Magister Scientifiae, Facultad de Ciencias Químicas y Farmacia, Universidad de San Carlos de Guatemala/INCAP.* 1973.

See also abstract 3.2 and 6.3

## 6. FEEDING VALUE. SHEEP AND GOATS

#### 6.1

*Lewy, V.S., Mand Work, S.H.* GOATS TEST FEED VALUE OF COFFEE PULP. *Agriculture in the Americas* 7(3): 54-55, 58. 1947.

This is a general article which brings out the importance of using goats for feeding and digestibility trial due to their small feed



requirements and the ease for manipulating in digestibility cages. The article also contains general information on procedures to follow in digestibility trials and a brief reference to an experiment where coffee pulp was fed to goats in combination with banana leaves. Details of the results obtained in this experiment are reported by Van Severen and Carbonell (Abstract No. 3.7).

## 6.2

*Morgen, A., Berger, C. et al AUSNUTZUNGSVERSUCHE MIT 14 FUTTERMITTELN NEBST ERURTERUNGEN UBER DIE URSACHE DER SOGENANTEN VERDAUUNGSDEPRESSION. [Experiments on the Utilization of 14 Feedstuffs and Explanations for the Depression in Digestibility]. Landwirtschaftliche Versuchstation 92:57-126. 1918.*

Editor's note: The following abstract was obtained from the review by Barbera (abstract No. 11.2) and not from the original paper which was not available.

Some tests were run with mixtures of used ground coffee, chickory, and several cereals, in combination with hay in the proportion of 30%. This feed was almost undigestible and so unpalatable to the sheep in the experiment, that only one of the animals finished the test alive. It was concluded that the use of spent coffee grounds should only be as a feed component for cattle, and only during periods of extreme necessity and under the condition of obtaining it at very low prices.

## 6.3

*Robayo, B. A. ENSAYO SOBRE LA UTILIZACION DEL CAFE EN LA ALIMENTACION DE OVINOS Y PORCINOS. [An Experiment on the Utilization of Coffee in Sheep and Swine Feeding]. National University of Colombia, Revista de la Facultad de Medicina Veterinaria y de Zootecnia 24(121): 718-726. 1961.*

## 6.4

*Rogerson, A. NUTRITIVE VALUE OF COFFEE HULLS. East African Agricultural Journal 20:254-255. 1955.*

Two digestibility trials are reported using in one case, oat hay as the basal diet and in the other case, Kikuyu grass hay. In each case, two Masai-type wethers were used, receiving 300 g hay and 200 g coffee hulls daily. When oat hay was used, the following composition (in parenthesis) and digestibility coefficients for coffee hulls were found ( crude protein (10.2) 13.5; ether extract

(1.6) 93.5; crude fiber (35.5) 26.1; nitrogen-free extract (45.7) 48.7; dry matter (100) 39.1; organic matter (92.9) 38.2. When Kikuyu grass hay was the basal feed, the composition and digestibility values (%) of coffee hulls were: crude protein (9.2) 7.0; ether extract (2.0) 12.9; crude fiber (29.7) 29.6; nitrogen-free extract (51.5) 51.6; true protein (7.7) 8.1; dry matter (100) 42.6; and organic matter (92.5) 41.9. Based on these findings, the author concluded that despite its acceptance by sheep, coffee hulls can hardly be classed as a useful basic feed and certainly cannot be regarded as a concentrate supplement.

## 7. FEEDING VALUE. DAIRY COWS

### 7.1

*Centro Nacional de Agronomía de El Salvador. USO DE LA PULPA DE CAFE SECA COMO ALIMENTO PARA EL GANADO. [The Use of Dried Coffee Pulp as a Feedstuff for Cattle]. El Café de El Salvador 17(200):1157-1160. 1947.*

Due to chronic scarcity or high feed costs, a proposal is presented for the study of products (especially coffee pulp) largely unknown with regard to their nutritive value. Based on promising results obtained by the Centro Nacional de Agronomía, these studies should continue at a Central American level and in the areas of research, extension and demonstration. In conjunction with these studies, advanced countries outside the area, should run digestibility and feeding trials with milking cows. The article includes a table with chemical composition data for coffee pulp and other feedstuffs.

### 7.2

*Mather R.E. and Apgar, Jr., W.P. DRIED EXTRACTED COFFEE MEAL AS A FEED FOR DAIRY CATTLE. Journal of Dairy Science 39(7): 938. 1956.*

Residue from soluble coffee manufacture was evaluated as a feed ingredient in 3 studies. Both dried extracted coffee meal and CoMol (69% liquid molasses equivalent dried with coffee meal) were studied. Sixteen Holstein cows in four 4 x 4 latin squares were used, 2 with coffee meal (0, 6, 12 and 18%) and 2 with CoMol (0, 8, 16 and

24%). Periods were 4 weeks or 3 weeks (one square). There was no significant effect on milk production, butterfat percentage, pulse rate, or flavor of the milk. Body weight of cows on coffee meal was significantly reduced. Some cows refused coffee meal or CoMol at the highest levels but 2 other cows ate up to 5.2 lb coffee meal for 100 days without refusal or undesirable effects. Fifteen Holstein and Guernsey calves received starters containing 0, 10, or 20% CoMol from 5 to 25 weeks of age. Reduce rate of growth could be explained by lower consumption owing to poor palatability of CoMol. Chromic oxide and chromogen techniques were used with 4 milking Holstein cows in 3 periods, giving estimates of  $10.2 \pm 3.0\%$  protein digestibility,  $1.3 \pm 0.5\%$  digestible protein, and  $55.8 \pm 3.6\%$  TDN.

### 7.3

Work, S.H., Van Severen, M.L. and Escalon, L. INFORME PRELIMINAR DEL VALOR DE LA PULPA DE CAFE SECA COMO SUBSTITUTO DEL MAIZ EN LA RACION DE VACAS LECHERAS. [Preliminary Report on the Value of Dry Coffee Pulp as a Substitute for Corn in Dairy Cattle Rations]. *Café de El Salvador* 16(185): 773-780, 1946.

Also in: *El Café de El Salvador* 18(201): 27-35, 1948.

*El Café de El Salvador* 19(218): 1505-1538, 1949.

*La Utilización de la Pulpa Seca del Café como Alimento para el Ganado en los Países Tropicales de América. El Campo (México)* 19(710): 72-77 and (711): 70-74, 76, 1951.

Two rations were compared in one of which dry coffee pulp was used to substitute for the corn of the other ration. These rations were tested on 6 lactating cows, three cows in each treatment. The level of coffee pulp used in the ration was 35%, on dry basis. However, considering the consumption of green fresh grass, the actual percentage coffee pulp in the total amount of feed consumed was 14% on dry basis. The trial lasted for 12 weeks. The corn-containing ration produced 9.25% more milk (4% fat-corrected) than the ration containing coffee pulp; however the difference was not statistically significant. The dry matter content of coffee pulp was 81.3%. On dry basis, the following chemical components were found: protein 8.9% nitrogen-free extract 63.7%, fiber 15.6%, ether extract 3.1% ash 8.7% calcium 0.35% and phosphorus 0.9%. In addition, observations over the period of one year led the authors to conclude

that it was not necessary to grind the dry pulp in order to achieve large intakes; also, milk production was most economical when coffee pulp was used; finally, coffee pulp would appear to be an excellent source of calcium and phosphorus, two elements that are chronically scarce in tropical dairy rations.

See also abstracts 3.1, 3.2 and 9.6.

## 8. FEEDING VALUE. BEEF CATTLE

### 8.1

Anonymous COFFEE PULP AS A PROTEIN CATTLE FOOD. *Forecast* 10: 264-268, 1948.

### 8.2

Ayala, R.E. PULPA DE CAFE Y MAZORCA DE MAIZ EN ENGORDA DE TERNEROS HOLSTEIN. [Coffee Pulp and Corn and Cob Meal for the Fattening of Holstein Calves]. *Revista Mexicana de Producción Animal* 3(1): 11-15, 1971.

A feeding trial was conducted with Holstein bull calves reared artificially, six animals per group, and with an initial weight of 120 kg. The diets consisted of corn silage *ad libitum* and three supplements: one with corn and cob meal at 75% of the dry mix, in the second diet half of the corn and cob meal was substituted by dry coffee pulp and in the third diet 3/4 of the corn and cob meal was substituted by the coffee pulp. Daily gains were 778, 627 and 459 g respectively. Since the decrease in daily gain is almost proportional to the increase in coffee pulp content it was concluded that the pulp was contributing practically no nutritional elements to the respective diets. Dry matter required per kg of weight increase was 8.99, 11.08 and 13.93 respectively proving again the low value of the pulp. On the 75% corn and cob meal diet there were promising economic results with a margin of 33% in sale price over feed costs.

### 8.3

Ayre-Smith, R.A. REPORT ON CATTLE HULLING FEED. *K.I.O. Fortnightly* 290: 2, 1955.

#### 8.4

*Bara H., M., Espinosa, F.M. and Guerrero, M.S.* DETERMINACION DEL NIVEL ADECUADO DE PULPA DE CAFE EN LA RACION DE NOVILLOS. [Determination of an Adequate Level of Coffee Pulp in Rations for Steers]. *Agricultura en El Salvador* 10(2): 27-35, 1970.

Thirty steers were used to compare a maintenance ration, based on Elephant grass (*Pennisetum purpureum*) silage, molasses and cottonseed meal, to other rations where 15 or 30% of the grass was replaced with coffee pulp either dried or ensiled. These rations were fed at a level calculated to produce one pound of gain/day. Satisfactory gains were obtained with the control diet (1.36 lb/day) and with the diets with 15% coffee pulp either dried or ensiled (1.43 and 1.46 lb/day, respectively). Coffee pulp at a level of 15% does not reduce animal performance. However, when coffee pulp was used at a level of 30%, the rate of weight gain decreased with respect to that obtained with the control diet. There were no signs of rejection of these rations. No adverse physiological effects attributable to coffee pulp were observed. Consumption of minerals was within normal values with all diets.

#### 8.5

*Berglund, R.* DRIED COFFEE GROUNDS USED IN FORMULA FEEDS. *Feedstuffs* 36(37): 44-45, 1964.

#### 8.6

*Bolaños, J.R.* LA PULPA DE CAFE COMO ALIMENTO PARA GANADO. [Coffee Pulp as a Feedstuff for cattle]. *Report Presented by the Asociación Cafetalera de El Salvador at the First Congreso Pecuario Nacional, held in San Salvador, May 1953. El Café de El Salvador* 23(258-259): 217-218, 1953.

Also in: *Lamatepec, Series 2, 17: 3875-3876, 1953.*

Due to the great limitation in grazing areas and the restrictions that it implies on the growth and development of cattle, the development of an intensive cattle operation in stables with the use of coffee pulp is proposed. Also suggested is the use of coffee pulp as the covering material for grass silage, which apparently improves the nutritional value of the silage in a way similar to that effected by corn. Also emphasized is the usefulness of coffee pulp as an organic fertilizer used either directly or after its previous use in animal feeding.

#### 8.7

*Cabezas, M.T., Estrada, E., González, J.M., Braham, J.E. and Bressani, R.* PULPA DE CAFE Y CAFEINA EN RACIONES PARA TERNEROS. [Coffee Pulp and Caffeine in Rations for Dairy Calves]. *IV Meeting of ALPA (Latin American Association of Animal Production), México, Abstract R-15, 1973.*

In order to find out if coffee pulp contains caffeine in toxic quantities for the growing ruminant, five groups of 6 Holstein bull calves of 100 days of age, and averaging 95.5 kg of body weight, were fed *ad libitum* for 99 days with the following rations: 1) the control ration containing 48% cotton hulls, 15% wheat bran, 15% cottonseed meal, 20% molasses, 1% urea and 1% minerals; 2) 0.15% caffeine provided by 30% dehydrated coffee pulp; 3) 0.11% caffeine provided by 30% dehydrated coffee pulp silage; 4) 0.12% pure caffeine; 5) 0.24% pure caffeine. At the beginning and at the end of the experiment, the calves were weighed and bled for biochemical analyses of the blood serum. The average daily gain and the feed consumption for the five groups were: 1.21 and 8.2; 1.00 and 7.3; 1.5 and 7.1; 1.21 and 8.1; and 0.95 and 6.8 kg, respectively. Both values were significantly lower ( $P < 0.05$ ) when the rations contained coffee pulp or 0.24% pure caffeine. The addition of 0.12% pure caffeine gave similar results to the control ration, suggesting that the negative results of the coffee pulp were produced by other factors either directly or in combination with caffeine. The serological analyses did not reveal any differences or tendencies that could explain the previous results. In studies on the balance of nitrogen run on other bull calves of similar age and body weight, the coffee pulp produced an increase in the urinary nitrogen excretion and a decrease in nitrogen retention.

#### 8.8

*Choussy, F.* LA PULPA DE CAFE COMO ALIMENTO DEL GANADO. [Coffee Pulp as Cattle Feed]. *Anales del Instituto Tecnológico de El Salvador* 1(1): 265-280, 1944.

#### 8.9

*Escalón Panamá, L.* LA PULPA DE CAFE COMO PROBLEMA NACIONAL. [Coffee Pulp as a National Problem]. *Congreso Pecuario Nacional (El Salvador), Memoria 1: 160-163, 1953.*

### 8.10

*Flores, F. BIO-ECONOMIC RESPONSE OF FATTENING STEERS TO DIFFERENT DIETARY LEVELS OF COFFEE PULP SILAGE AND PROTEIN. Thesis Magister Scientiae, IICA, Turrialba, Costa Rica, 1973, 61 p.*

Sixty-five Zebu-Criollo steers with an initial weight of 229 kg were used to study the biological and economic effects of the following dietary levels of protein: 6.0, 8.6, 15.0, 21.4 and 24.0% and coffee pulp silage (dry matter): 0, 8.8, 30.0, 51.2 and 60.0%. All treatments were isocaloric. The average dry matter intake was 1.96 kg/100 kg liveweight. Intake increased with increasing levels of protein but decreased with increasing levels of coffee pulp. Weight gain increased with increasing levels of protein intake up to a protein level of 319 g/100 kg liveweight beyond which the weight gain reached a plateau. Coffee pulp had a negative effect on weight gain. This effect was attenuated by additions of protein. The average daily weight gain for all treatments was 434 g/head. Feed conversion to weight gain was improved by increments in the level of protein up to a protein concentration of 15%. Coffee pulp had no definable effects on the efficiency of feed conversion. The overall mean value was 23.1 kg of feed per kg of weight gain. The highest gross economic return (U.S.\$0.18/animal/day) was obtained with intakes of 315 and 504 g/100 kg liveweight, for protein and coffee pulp, respectively. With this combination, the daily weight gain was 500 g/head.

### 8.11

*Inter-American Institute of Agricultural Sciences. LA PULPA DE CAFE COMO ALIMENTO PARA GANADO. [Coffee Pulp as a Cattle Feed]. Inter-American Conference on Agriculture, Trabajo Técnico 4: 245-250. 1951.*

### 8.12

*Jarquín, R., Bressani, R., González, J.M. and Braham, E. PULPA DE CAFE EN ALIMENTACION DE RUMIANTES. [Coffee Pulp in Cattle Feeding]. ALPA (Latin American Association of Animal Production) 6: 106, 1971.*

Dehydrated coffee pulp at the levels of 0, 10, 20 and 30% in substitution of cottonseed hulls, was used in the feeding of young Holstein calves. The other ingredients (cottonseed meal, wheat bran, molasses and minerals) were held constant in all

ration. Four homogeneous groups of 8 animals each were formed, balancing age and weight. The experiment had a duration of 12 weeks. Before the start of the trial, all calves were fasted for 16 hours in order to obtain blood samples from the jugular vein. This sampling was continued every 4 weeks during the experimental period. Feeding was *ad libitum* and weighing took place weekly. Feed efficiency values for the 10, 20 and 30% coffee pulp were 5.8, 6.6 and 6.2, respectively, and were not statistically different to the value observed with the control group (6.2). The daily weight gains were 725, 725, 589 and 544 grams, for the groups 1, 2, 3, and 4, respectively, indicating an inverse relationship with the coffee pulp content in the ration. Serum levels of protein, albumen, urea nitrogen, creatine and glucose showed no significant differences between the levels of coffee pulp and the control group. Variations during the experimental period were not significant.

### 8.13

*Jarquín, R., González, J.M., Braham, J.E. and Bressani, R. PULPA Y PERGAMINO DE CAFE. II. UTILIZACION DE LA PULPA DE CAFE EN LA ALIMENTACION DE RUMIANTES. [Coffee Pulp and Parchment. II. Utilization of Coffee Pulp in Ruminant Feeding]. Turrialba 23(1): 41-47. 1973.*

Sun-dehydrated coffee pulp was ground and added to a basal diet so as to replace 0, 10, 20 and 30 per cent of the cottonseed hulls in the diet. Two studies were carried out covering 12 and 24 weeks, respectively, with young castrated Holstein calves, approximately 76 days of age. Diets were fed *ad libitum*. In both studies, average weight gain and feed efficiencies were inversely related to the coffee pulp content in the diet. However, differences in these parameters among groups tended to decrease in regard to time. None of the blood biochemical measurements taken were statistically different among dietary treatments. The digestibility trials carried out revealed similar levels of total digestible nutrients between diets, independent of their coffee pulp content. A small increase, however, was evident when the diet contained higher levels of coffee pulp, but this did not reflect in the performance of the animals. It was concluded that the effects observed were related to lower feed intake levels as the coffee pulp content in the diets tested increased. At present, 10 per cent coffee pulp could be recommended as a safe component for use in mixed cattle feed.

#### 8.14

Jarquín, R., González, J.M. and Bressani, R. UTILIZACION DEL PERGAMINO DE CAFE EN ALIMENTACION DE RUMIANTES. [Utilization of Coffee Parchment in Cattle Feeding]. IV Meeting of ALPA (Latin American Association of Animal Production), México, Abstract R-25. 1973.

The use of coffee parchment (CP — an anatomical fraction composed of the film surrounding the dry coffee seed without pulp—) as a substitute of dry ground corn plant leaves was investigated with Holstein calves 85 days old and 87.8 kg in weight. Levels of 0, 15 and 30% of CP were used to replace equal amounts of corn leaves in a basal ration of the following composition: cottonseed meal 25%, wheat bran 24%, corn leaves 30%, minerals 1% and molasses 20%). Also, rations with 30% CP with urea, or with urea and molasses, were tested using groups of 6 animals/treatment during 91 days. Weight gains (109, 0.99 and 0.89 kg/day) and feed efficiency (5.75, 6.16 and 6.38) were inversely correlated with the levels of CP. Addition of 1.5% urea to the ration with 30% CP did not improve weight gains (0.91 kg/day) nor feed efficiency (6.38). Addition of 28.5% molasses improved animal growth (1.05 kg/day). The effect of pelleting CP on the nutritive value of the ration was also studied. To this effect, a ration with 0% CP was compared to two rations with 30% CP either ground or pelleted. Seven animals/group were used with an initial weight of 147.7 kg. The test had a duration of 150 days. The following results were obtained for the 0% CP, 30% ground CP and 30% pelleted CP rations. Final weights: 312, 292 and 302 kg; daily weight gain: 1.18, 1.03 and 1.09 kg; and carcass yield: 50.3, 44.2 and 47.3%, respectively. From the economic point of view, it is advantageous to use 30% CP as a substitute of dry, ground corn leaves.

#### 8.15

Jarquín, R., Murillo, B., González, J.M. and Bressani, R. PULPA Y PERGAMINO DE CAFE. VII. UTILIZACION DE PERGAMINO DE CAFE EN LA ALIMENTACION DE RUMIANTES. [Coffee Pulp and Parchment. VII. Utilization of Coffee Parchment in Ruminant Feeding]. Turrialba 24(2): In Press. 1974.

Coffee hulls are considered a waste by-product of the coffee industry, with high availability in Latin America. The purpose of the work herein described was to evaluate this material as a bulk ingredient for cattle rations, at levels up to 30% of the whole ration, as a substitute of corn fodder. The effect of the addition of urea nitrogen and of a high level of carbohydrates to diets with 30% of

coffee hulls was also studied. The results indicated an inverse relationship between the level of coffee hulls used and the average daily gains and feed conversion values. The addition of urea nitrogen or soluble carbohydrates, as molasses, to the ration with 30% of coffee hulls did not yield better results than the control diet. Pelleting did not improve either daily gains or feed conversion, although feed consumption did increase. Fractionation of carbohydrates revealed that coffee hulls are very high in lignin, suggesting a low dry-matter digestibility, as confirmed by *in vitro* digestibility studies. According to the results, coffee hulls can be used in cattle rations in amounts as high as 30% of the total diet.

#### 8.16

Ledger, H.P. and Tillman, A.D. UTILIZATION OF COFFEE HULLS IN CATTLE FATTENING RATIONS. *East African Agricultural and Forestry Journal* 37(3): 234-336. 1972.

Thirty-two steers were used in a feedlot trial to determine the effect of replacing ground maize in a highly concentrated cattle fattening ration, with 10, 20 and 30% coffee hulls. Eight animals were fed on each diet and were individually fed *ad libitum* for 89 days. Feed records were recorded daily and the steers were weighed once every 14 days. The addition of 10 or 20% coffee hulls did not affect feed intake, gains or feed conversions, however, the addition of 30% coffee hulls reduced ( $P < 0.001$ ) feed intake, gains and feed conversion. It appeared that coffee hulls improved the utilization of the remaining portion of the diet, when used at a level not exceeding 20% of the ration. Higher levels probably decreased feed consumption due to a slower rate of passage.

#### 8.17

Madden, D.E. THE VALUE OF COFFEE PULP SILAGE AS A FEED FOR CATTLE. Thesis Magister Agriculturae. IICA, Turrialba, Costa Rica. 58 p. 1948.

Two groups of 10 steers each were fed on a comparative-type feeding trial. They were 3 to 5 year-old steers of local type, graded "common" as feeder steers. The control group received a ration consisting of Napier grass, concentrates and a mineral mixture. The second group of steers received the same ration in which 67% by weight of the Napier grass was replaced by coffee pulp silage. The groups were placed in dry lots and fed at regular intervals. Average daily coffee pulp consumption per steer in the silage group over the 77 day period was 22.5 kg. Maximum consump-

tion was obtained during the latter part of the trial, with consumption up to 28.6 kg of coffee pulp silage/steer/day, in addition to consumption/steer/day of approximately 14.1 kg of Napier grass, 2.72 kg of molasses and 2.27 kg of cottonseed meal. Daily gains per steer were 331 and 322 g. for the control and coffee pulp groups, respectively. Daily TDN consumption per steer was 7.54 kg for the control group and 5.95 kg for the silage group. Average daily consumption of coffee pulp silage per steer was 22.5 kg or 5.5 kg silage consumed daily per 100 kg liveweight. Analysis of the experimental data indicated no significant difference between the two rations. It was concluded, therefore, that coffee pulp silage is not superior to Napier grass as a roughage for cattle.

#### 8.18

*Osegueda Jiménez, F.L., Quiteño, R.A., Martínez, R.A. and Rodríguez Ch., M.* USO DE LA PULPA DE CAFE SECA EN EL ENGORDE DE NOVILLOS EN CONFINAMIENTO. [Utilization of Dry Coffee Pulp in Feedlot Feeding]. *Agricultura en El Salvador* 10(1): 3-9. 1970.

An experiment was conducted to study the feasibility of using sun-dried coffee pulp in rations for fattening steers. Twenty-four steers were equally distributed in 4 groups. The average initial weight was 335 kg. The initial age varied between 18 and 24 months. All animals were one-half Brahman. The feeding was effected twice a day, providing *ad libitum* amounts of water, mineralized salt, oyster shell meal and bone meal. At the end of a 98-day experimental period, group 1 (0% coffee pulp) reached an average final weight of 471 kg vs. 457 kg for group 2 (10% coffee pulp), 418 kg for group 3 (20% coffee pulp) and 372 kg for group 4 (30% coffee pulp). The values for conversion efficiency of feed to weight gain were 9.02, 9.34, 10.89 and 16.28, for groups 1, 2, 3 and 4, respectively. The feeding costs per 100 kg produced were US\$30.08 for group 2; US\$30.19 for group 3; US\$32.94 for group 1 and US\$38.55 for group 4. However, when the experimental period was divided in two phases, 0-8 and 8-14 weeks, it became evident that groups 3 and 4 were the most economical. Apparently, an adaptation period of 4 to 6 weeks is necessary when coffee pulp is used at the levels of 20 and 30% of the ration. Palatability was one of the reasons for the decline in feed consumption when coffee pulp is used. Feed intake improved after adding molasses to the concentrate beginning in the fourth week. Molasses-containing feed cannot be allowed to stand for more than 3 days as consumption declines. Two steers from each experimental group

were sacrificed at the end of the experiment providing the following data on carcass yield: 56.7, 56.3, 54.3 and 53.9%, for groups 2, 1, 4 and 3, respectively. The hind quarters yields, expressed as percentage of the chilled carcass, were 49.2, 48.7, 48.6 and 48.0, for groups 1, 2, 3 and 4, respectively.

#### 8.19

*Pan-American Union.* THE USE OF DRIED COFFEE PULP AS A FEED. 1947. *Mimeo.*

#### 8.20

*Pustelnik, W.* OBSERVACIONES SOBRE LA PULPA DE CAFE FERMENTADA COMO ALIMENTO PARA ANIMALES. [Observations on the Use of Fermented Coffee Pulp as a Feed for Animals]. *Venezuela, Instituto Nacional de Agricultura, Publicación Miscelánea* 3: 48-49. 1952.

#### 8.21

*Ramírez, S. and Waugh, R.K.* TORTA DE CAFE PARA GANADO BOVINO. [Coffee Cake for Cattle]. *Agricultura Tropical (Colombia)* 19(5): 257-263. 1963.

Three experiments were conducted to determine acceptability and nutritive value of coffee cake (de-oiled berry) using Holstein heifers and young bulls of 8 to 12 months of age. The palatability trial included coffee cake levels from 0 to 98% of the ration (dry matter of coffee cake: 89.7%); it was found that as the level of coffee cake increased, consumption decreased. The highest intake (3 kg/head/day) was obtained at the levels of 0 and 25% coffee cake. At the 50% level, feed consumption was 96.5% of the maximum. At the 75% level, feed intake decreased to 64.5% of the maximum, and at the 98% level of coffee cake, feed intake was lowest (29.4% of the maximum intake). The other trials showed that as the level of coffee cake increased to 25 and 50%, the rate of weight gain decreased. The values for the 0, 25 and 50% levels were 0.90, 0.82 and 0.63 kg/day, respectively. In the same order, feed consumption values were 7.5, 7.3 and 6.7 kg dry matter/day. The decrease in weight gain was not only due to a decrease in feed consumption. This was proven in a third trial where an addition of coffee cake to a basal intake caused a reduction in weight gain from 0.573 to 0.481 kg. This effect was not prevented by the addition of molasses (0.493 kg/day).

## 8.22

Squibb, R.L. EL EMPLEO DE LA PULPA DE CAFE COMO ALIMENTO DE GANADO. [The Use of Coffee Pulp as Feed for Cattle]. *Revista de Agricultura (Costa Rica)* 17(8): 389-401. 1945.

Also in: Squibb, R.L. *El Ensilaje de Pulpa de Café en el Engorde de los Becerros*. [Coffee Pulp silage for Fattening Steers]. *La Hacienda* 40(7): 438-441. 1945.

Coffee pulp silage was fed to steers in four trials conducted at Turrialba. The first trial was designed to determine normal animal performance on pasture (*Melinis minutiflora*). Ten steers were used on a 16.2 ha grazing area during a 90-day period. The supplement consisted of a mixture of salt, bone meal and oyster shell given at a level of 54 g/head/day. The daily gain was 0.727 kg. The second trial was carried out with 6 animals in dry lots. Coffee pulp silage was available *ad libitum*. In addition, the following feeds were given in kg/head/day: cottonseed meal 0.38, sugarcane molasses 0.163, and salt, bone and oyster shell meal mixture 0.154. This trial was terminated after 25 days due to refusal to eat. The average daily consumption of coffee pulp was 4.41 kg/head and the average daily weight loss was 0.38 kg. The third feeding trial also involved 6 animals and coffee pulp silage *ad libitum*; other feeds included (kg/head/day): whole peanut meal 0.453, cane molasses 1.5, rice bran 1.59 and salt and mineral mixture 0.154. At the end of a 28-day period the average coffee pulp consumption had been 10 kg/head/day while the weight loss was 0.109 kg/day. As a result of these findings green grass (*Paspalum virgatum*) was added to the feeding regimen at a rate of 5.99 kg/head/day during 35 days. The effects consisted of an increase in coffee pulp intake (14.4 kg/head/day) and a weight gain of 0.7 kg/day. Again, the treatment was modified by the addition of 0.9 kg safflower meal/head/day, during a 21-day period; as a result, weight gain increased to 1.41 kg/day but coffee pulp intake remained at 14.5 kg/head/day. In the fourth trial, two groups of grazing animals were compared, one of the groups receiving a supplement of coffee pulp silage *ad libitum*, 1 kg molasses and 68 g salt mixture/head/day. This supplementation was accomplished by allowing the animals access to a feed lot twice a day two hours each time. The group on

pasture only, gained 0.535 kg/day/head during the 35-day experimental period while the supplemented group gained 0.812 kg/day and consumed 8.07 kg of coffee pulp/head/day. In view of these results it was concluded that the differences observed in the third trial were due mainly to the supplementary protein.

## 8.23

Squibb, R.L. EL ENSILAJE DE PULPA DE CAFE EN EL ENGORDE DE LOS BECERROS. [Coffee Pulp Silage for Fattening Steers]. *La Hacienda* 40(7): 438-441. 1945.

See abstract 8.22: Squibb, R.L. El empleo de la pulpa de café en la alimentación de ganado. (The use of Coffee pulp as feed for cattle). *Revista de Agricultura (Costa Rica)* 17(8): 389-401. 1945.

## 8.24

Valencia M., M LA PULPA DE CAFE EN LA ALIMENTACION DEL GANADO. [Coffee Pulp in Livestock Feeding]. *Boletín Agrícola de la Sociedad Antioqueña de Agricultura (Colombia)* Nos. 350-351: 3007-3013. 1948.

In this communication the author describes research achievements on the feeding value of coffee pulp, obtained by F. Choussy, S. Work, M.L. van Severen and L. Escalón (El Salvador), R. Squibb (Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica) and D. Echevarría (Colombia). Abstracts of these works are included in this Annotated Bibliography (Editor's note). Moreover, the author discusses certain problems inherent to the utilization of coffee pulp such as transportation costs, drying and palatability. However, considering the extent of its production and in the light of research results, the author proposes that more research on the subject should be conducted in Colombia with the aim of incorporating into the country's economy a potentially nutritive resource.

See also abstracts 9.3, 9.4 and 15.2.

## 9. PHYSIOLOGICAL EFFECTS ON ANIMALS

### 9.1

*Bickel, A., Van Eweyk, C. und Fleischer, F.* BEEINFLUSST DER GENUSS VON KAFFEEINFUS DIE VERWEILDAUER DER SPEISEN IN MENSCHLICHEN MAGEN? [Influence of Coffee on the Time that Food remains in the Human Stomach]. *Arch. Verdauungs-Krankh.* 40(5/6): 334-338, 1927.

Neither whole nor caffeine-free coffee influences the emptying time of stomach.

### 9.2

*Cabezas, M.T., González, S.M. and Bressani, R.* PULPA Y PERGAMINO DE CAFE. V. ABSORCION Y RETENCION DE NITROGENO EN TERNEROS ALIMENTADOS CON RACIONES ELABORADAS CON PULPA DE CAFE. [Coffee Pulp and Parchment. V. Nitrogen Absorption and Retention in Calves fed Coffee Pulp Rations]. *Turrialba* 24(1): 90-94, 1974.

Nitrogen balance data of male, young Holstein calves, weighing 122 kg, fed diets containing 0, 12, and 24 per cent of dehydrated coffee pulp, are presented. These diets were administered for a total of 18 days, with an adaptation period of 8 days and two 5-day balance periods for quantitative collection of feces and urine. The results showed a significant decrease in the nitrogen retained by the animals as coffee pulp in their diet increased from 0 to 14 per cent. A considerable increase in urine output was also observed as the percentage of coffee pulp in the diet increased, as well as a tendency for food intake and nitrogen digestibility to decrease.

### 9.3

*Cabezas, M.T., Murillo, B., Jarquín, R., González, J.M., Estrada, E. and Bressani, R.* PULPA Y PERGAMINO DE CAFE. VI. ADAPTACION DEL GANADO BOVINO A LA PULPA DE CAFE. [Coffee Pulp and Parchment. VI. Adaptation of Cattle to Coffee Pulp]. *Turrialba* 24(2): In Press, 1974.

A growth study, using 5 experimental groups of 6 Holstein steers each, was carried out to determine the adaptation of beef cattle to diets containing dehydrated coffee pulp as the main component. The experiment was carried out in two consecutive stages. The first lasted 102 days and was divided

into three periods of 34 days each. A 45-day period constituted the second stage of the study. The average initial weight of the animals was 213.3 kg and they were kept in corrals, where rations, mineralized salt, and water were available at all times, during the experimental periods. During the first stage of the study, groups No. 1, 2 and 4 were fed *ad libitum* rations containing 0, 30 and 48% coffee pulp, in that order. Groups No. 3 and 5, were also fed *ad libitum*, but the amount of coffee pulp in their rations was increased from 10 to 20 and to 30%, and from 16 to 32 and to 48% respectively. In all cases, coffee pulp substituted cottonseed hulls in the rations. In the second stage of the study, all five groups of steers were fed *ad libitum*, coffee pulp with 20% molasses, plus 1.8 kg of a protein-calorie supplement, per animal, per day. Results obtained in the first stage of the experiment showed that feed consumption and weight gain, decreased as the daily intake of coffee pulp increased. The findings for the different periods of this part of the experiment, however, showed that when the animals consumed 30% of coffee pulp, they became adapted to the diet. Lower levels of coffee pulp intake were not capable of adapting the animals to consume and to utilize higher amounts of pulp. The adaptation phenomenon was also evident in the second stage of the study, where the overall performance of the animals that consumed coffee pulp in the initial phase of the experiment, was better than that of those which did not consume previously this by-product of the coffee industry.

### 9.4

*Estrada, E.* CAFEINA Y TANINOS COMO FACTORES LIMITANTES EN EL USO DE LA PULPA DE CAFE EN LA ALIMENTACION DE TERNEROS. [Caffeine and Tannins as Limiting Factors for the Use of Coffee Pulp in Calf Feeding]. *Thesis Magister Scientifical, Facultad de Ciencias Químicas y Farmacia, Universidad de San Carlos de Guatemala/INCAP.* 1973.

### 9.5

*Evert, G., Niedobitek, F. and Schmid, E.* ULZEROGENE KOMBINATIONSEFFEKTE VON EMOTIONELLEM STRESS UND KOFFEINBZW. BOHNENKAFFEE IM TIERVER-SUCH. [Multiple Ulcerogenic Action caused by Emotional Stress plus Caffeine or Coffee as Observed in Animal Experiments]. *Z. Gastroenterol.* 9(2): 94-100, 1971.

The contribution of caffeine intake to ulcer formation was studied in the rat during immobilization stress. Caffeine and coffee increase ulcer incidence in immobilized animals. The action of



caffeine-free coffee and coffee with low caffeine and chlorogenic acid content could not be differentiated from that of a placebo. The tests performed furnished evidence of a pathogenetic action of caffeine in doses that could correspond to the consumption of 2-3 cups of coffee in humans. The importance of multiple ulcerogenic action in animal and human experiments was discussed.

#### 9.6

*Hawkins, G.E. and Davis, W.E. CHANGES IN PLASMA FREE FATTY ACIDS AND TRIGLYCERIDES IN DAIRY CATTLE AFTER DOSING WITH COFFEE OR CAFFEINE. Journal of Dairy Science 53(1): 52-55, 1970.*

Two hours after 50 to 100 g of coffee were given intraruminally as a drench or through an established fistula, there was a marked increase in plasma levels of free fatty acids in 14 of 18 cows and an increase in plasma triglycerides in all six cows on which this component was measured two hours post-treatment. Also, when 10 g of caffeine citrate, a highly soluble form of caffeine, were infused intraruminally, there was an increase of 88.6% in plasma levels of free fatty acids compared with controls. However, there were no detectable changes in plasma levels of free fatty acids and triglycerides two hours after 5 g of USP grade caffeine, a low solubility product, was injected intraruminally as a suspension in 30 ml of water. The lack of a response to the USP grade caffeine appears to be associated with its low solubility. Feeding powdered instant coffee in the concentrate was not a practical means of getting caffeine into cattle, as they consumed an average of only 33.3% of their allowance. This resulted in low and highly variable intakes of coffee.

#### 9.7

*Heyden, S. DOES COFFEE INFLUENCE THE LIPID METABOLISM? Z. Ernahrungswiss 9(4): 388-396, 1969.*

An attempt was made to demonstrate that with several conditions which cause an increment in free fatty acids a subsequent rise in cholesterol levels is not observed. The temporary elevation of free fatty acids after coffee ingestion did not necessarily lead to an increase in serum cholesterol concentrations. Observation on rabbits (an animal species that has a species specific susceptibility for hypercholesterolemia and atherogenesis) showed that caffeine, regardless of the route of administration, over a 3 month period, had no hypercholesterolemia enhancing effect at all. From these experiments it appears that coffee does not exert a

negative influence on the fat metabolism and its sequelae.

#### 9.8

*Jaffe, W. and Ortiz, D.S. NOTAS SOBRE EL VALOR ALIMENTICIO DE LA PULPA DE CAFE. [Notes on the Feeding Value of Coffee Pulp]. Agro (Venezuela) 7(23): 31-37, 1952/1953.*

Analytical and biological trials were conducted with two types of coffee pulp: One was sun-dried 24 hours after depulping (I), and the other was allowed to ferment for 3 days before drying and grinding (II). Chemical analyses revealed the following composition of (I) and (II), respectively: Dry matter 85.6 and 87.2%; ash 8.3 and 11.7%; fat 2.3 and 1.6%; crude protein 10.9 and 13.4%; crude fiber 18.1 and 28.2%; nitrogen-free extract 85.6 and 87.2%; protein digestible with pepsin and HCl 4.6 and 3.6%; calcium 0.50 and 0.94%; phosphorus 0.11 and 0.11%; tannins 1.44 and 0.88%; caffeine 0.51 and 0.077%; alcoholic extract 6.00 and 2.60%; riboflavin 0.07 and 0.31 mg/100 g; and niacin 0.40 and 1.70 mg/100 g. Sprague Dawley rats were used for the biological tests. The rats were individually caged. Coffee pulp (I) proved to be highly toxic at the level used (50% of the ration) causing death in all 4 rats used in the treatment within 4 to 5 days. Coffee pulp (II) did not affect animal performance as compared to a control group. The toxic principle is neither caffeine nor the tannins and is extractable with alcohol. Fermenting coffee pulp (II) reduces the content of caffeine and tannins. It was concluded that because of its toxicity and high level of caffeine, non-fermented coffee pulp is not a suitable feed for livestock. On the other hand, it would appear that fermented coffee pulp can be of value as a feedstuff.

#### 9.9

*Tudoranu, G., Dimitriu, C.C. et Filipesco, M. INFLUENCE DE L'ABSORPTION GASTRIQUE DE QUELQUES SUBSTANCES SUR LA MOTILITE STOMACALE (VISCEROGRAFIE). [Influence of Various Substances on Gastric Motility]. Bulletin Academie Medecine Roumanie 9(1): 61-67, 1940.*

Substances such as glycerol, distilled water, and alcohol inhibit gastric motility. Coffee, NaCl, and bouillon cause a period of inhibition followed by an exaggeration of contractility. Administration of histamine leads to tetanic contractions lasting as long as an hour. With NaHCO<sub>3</sub>, periods of inhibition alternate with periods of tetanic contractions.

## 9.10

*Walker, Florence.* THE EFFECT OF CAFFEINE AND COFFEE EXTRACT ON THE ACTIVITY OF THE DIGESTIVE ENZYMES. *American Journal of Physiology* 139(3): 343-346. 1943.

A study was made of the effect of caffeine and coffee extract on the digestion *in vitro* of appropriate substrates by salivary and pancreatic amylases, by pepsin and trypsin, and by pancreatic lipase. Twenty mg and 40 mg of caffeine/100 cc of 1% starch dispersion had no effect on the conversion of starch to reducing sugars by ptyalin in fresh saliva, or by a commercial preparation of pancreatic amylase; nor did it affect the digestion of casein by pepsin and trypsin, or of olive oil by lipase. Coffee extract added in amounts calculated to furnish approximately 20 mg and 40 mg of caffeine/100 cc of substrate had no effect on the activity of pepsin and trypsin, but increased appreciably the rate of digestion of starch by salivary and pancreatic amylases, and retarded the digestion of olive oil by pancreatic lipase.

See also abstracts 4.1, 4.2, 4.3, 4.4, 4.5, 8.7, 8.12, 8.13, 8.16, 15.2 and 16.4.

## 10. AGRONOMIC USES

### 10.1

*Bollen, W.B. and Lu, K.C.* MICROBIAL DECOMPOSITION AND NITROGEN AVAILABILITY OF REACTED SAWDUST, BAGASSE, AND COFFEE GROUNDS. *Journal of Agricultural and Food Chemistry* 9(1): 9-15. 1961.

Wood wastes and similar residues treated by the Fersolin process are less readily decomposable than the raw materials, because of conversion of much of the cellulose to resistant complexes. This decreases or eliminates the microbial demand for available nitrogen when such organic products are added to the soil, imparts desirable lasting qualities, and prolongs physical effects. Bagasse, most decomposable in the raw state, gave a product showing greatest resistance increase. Reacted sawdust was most resistant. Coffee Fersolin showed a decrease in decomposability, but was less resistant than reacted bagasse or sawdust. The imparted resistance is desirable for increasing

persistence in the soil as well as decreasing nitrogen demands. All the reacted products carried nitrogen in excess of the requirements of microorganisms involved in their decomposition. Spent coffee grounds, because of their high nitrogen content, appear to be a promising material to process into a reacted product. Analysis of spent coffee grounds showed: 50.5% total carbon 2.0% total nitrogen, 320 ppm ammonium nitrogen, 145 ppm nitrate nitrogen, and 19,835 ppm bound nitrogen (protein nitrogen).

### 10.2

*Chandler, J.V., Boneta, E., Abruña, F. and Figarella, J.* EFFECTS OF CLEAN AND STRIP CULTIVATION, AND OF MULCHING WITH GRASS, COFFEE PULP, AND BLACK PLASTIC, ON YIELDS OF INTENSIVELY MANAGED COFFEE IN PUERTO RICO. *Journal of Agriculture of the University of Puerto Rico* 53(2): 124-131. 1969.

The effects of clean-and strip-cultivation, and of applications of coffee pulp, grass, and black-plastic mulches under rows of heavily fertilized, young, intensively managed, strip-cultivated coffee growing in an area with a market dry season were determined. Mulching with coffee pulp or grass increased soil water available to the coffee trees during the dry season and sharply reduced surface soil temperatures. The treatments had no marked effect on foliar composition of the coffee trees. Mulching with coffee pulp increased yields of strip-cultivated coffee over 3 bearing years from an average of 873 to 1,383 pounds of market coffee per acre yearly, but mulching with grass or black plastic did not affect yields. Strip-cultivated coffee produced as high yields as did clean-cultivated coffee. Yields of mulched coffee varied more widely from year to year than did those of clean or strip-cultivated coffee. Applications of coffee pulp as a mulch may be warranted on limited acreages of young, intensively managed coffee growing in full sunlight, particularly in regions with a marked dry season. Other mulch material is not readily available in the coffee region.

### 10.3

*López Andreu, C.* EL EFECTO DE LA PULPA DE CAFE COMO FERTILIZANTE. [The Effect of Coffee Pulp as a Fertilizer]. *Revista Cafetalera* 1(6): 25-26. 1962.

#### 10.4

*Parra H., J. and Calle V., H. CONVERSION DE LOS RIPIOS DE CAFE EN COMPOS. [Conversion of Coffee Debris into Compost]. Cenicafé (Colombia) 18(4): 103-115. 1967.*

Coffee debris refers to leftovers of the coffee threshing which include imperfect grains such as the black grains, cracked nuts, and the small berries. The drink prepared from this debris has a very low quality. The purpose of this study was to determine the possibility of converting coffee debris into an organic fertilizer. To study this conversion, the decomposition period was estimated, using as indexes the temperature and the chemical composition of the compost determined by measuring the carbon-nitrogen relationship, the requirement of chemical oxygen and the percentage of humus. In order to accelerate the decomposition process, treatments like grinding the material and the addition of superphosphate were tried. In all cases, fermentation was kept under aerobic conditions to obtain speedy results. It was found that grinding the material was the most effective treatment to accelerate the process of decomposition. Nevertheless the highest yields were obtained by using unbroken debris although this material took a few weeks longer to decompose; in both cases, compost of the same quality was produced.

#### 10.5

*Suárez de Castro, F. VALOR DE LA PULPA DE CAFE COMO ABONO. [The Value of Coffee Pulp as a Fertilizer]. Agricultura Tropical (Colombia) 16(8): 503-513. 1960.*

From the botanical point of view, the coffee berry is made up of: a) the epicarp or the seed exterior film; b) the mesocarp or the soft, colorless tissue; c) the endocarp or parchment; d) spermoderm or the silvery film; and e) the endosperm or nut (two in each berry). The epicarp and the mesocarp constitute the mesocarp which represents between 45 and 65% of the total weight of the berry. Passing the berries through a pulp peeler, not only releases the epicarp but also part of the mesocarp. This is the so-called coffee pulp, which is therefore, not a definite anatomical structure. Some data on the chemical composition of coffee pulp obtained in Colombia, Costa Rica and El Salvador is presented. Research data from several countries clearly show the usefulness of coffee pulp as an organic fertilizer in coffee plantations, giving better results than either an 8-8-8 fertilizer or applications of potassium or phosphorus.

See also abstracts 8.6, 11.4 and 13.1.

### 11. INDUSTRIAL USES. GENERALITIES

#### 11.1

*Aguirre B., F. LA UTILIZACION INDUSTRIAL DEL GRANO DEL CAFE Y DE SUS SUBPRODUCTOS. [The Industrial Utilization of Coffee Beans and Coffee By-products]. Guatemala, Instituto Centroamericano de Investigación y Tecnología Industrial (ICAITI). 1966. (Investigaciones Tecnológicas del ICAITI, No. 1).*

Research work on the industrial utilization of coffee and its by-products has been reported in widely scattered publications. In the main, research papers on the subject have been published in journals of limited circulation. Access to scientific literature in this field is therefore difficult. In the present work an attempt is made to gather in one unit the most important results from the last few decades of research on the industrial utilization of coffee and its by-products. Attention is drawn to the fact that most of the research work carried out in this field is, as yet, in the experimental stage. In spite of the vast potential of coffee as an industrial raw material, there is at present no sufficient data to determine the economic feasibility of the processes that have been successfully developed in the laboratory. No effort was spared in gathering a wide variety of research work on the subject, with a view towards establishing a frame of reference for the selection of the fields in which further study could yield productive results. A brief description of the chemical composition of coffee is also given in order to have the necessary background for future research on the industrial utilization of coffee.

#### 11.2

*Barbera, C.E. L'UTILISATION DU MARC DE CAFE. [The Uses of Coffee Grounds]. Café, Cacao, The 9(3): 206-218. 1965.*

After having brought into perspective the importance of the problem presented by the use of coffee grounds for the soluble coffee industry, the author makes an analytical survey of the literature (treatises, articles, patents) dealing with the industrial exploitation of this by-product since 1917. The main processes studied were those designed to produce oils, glycerides and fatty acids for industrial purposes and for feedstuffs; also humic fertilizers and soil-conditioners, hydrocarbon derivatives obtained by dry distillation, micro-porous substances and synthetic resins, and finally fuel. In conclusion, the author stresses the present day economic possibilities of this latter utilization and enables us to foresee later on a

possible outlet for the fertilizers and soil-conditioners and for the fats for industrial use.

Editor's note: Four articles, dealing with the use of spent coffee grounds in animal feeding, are cited and are included in this Annotated Bibliography with texts obtained from Barbera's review.

### 11.3

Pederson, C.S. and Breed, R.S. *Fermentation of Coffee*. *Food Research* 11(2): 99-106. 1946.

### 11.4

Punnett, P.W. SPENT GROUNDS CAUSE MAJOR SOLUBLE PROBLEM. *Tea and Coffee Trade Journal* 114(2): 18, 41-42. 1958.

The production of soluble coffees has produced a problem of having to dispose of the extracted coffee grounds. For every pound of soluble coffee that is made there are two pounds of dry coffee grounds, or four pounds of wet grounds which have to be disposed of. One major drawback to their use is the high water content (50-60%) which implies that coffee grounds could not serve as an efficient source of heat energy. On a wet basis, coffee grounds contain 10% crude oil; however, its extraction might not be economical because of the need to dry the material before extraction. Coffee grounds contain practically no caffeine and therefore, there is no possibility of extracting and selling this drug. It contains some mineral matter, particularly high in potash, which could be marketed after burning the grounds. It is possible to produce plastic from green coffee after oil and caffeine extraction. If oil were extracted from coffee grounds, there would remain a dry, granular powder with properties similar to sawdust which could be employed as a filler in various compositions. Another possibility is its use as mulch or organic material in agriculture. The author finally raises the question of the usefulness of coffee grounds for the production of chemicals by a fermentation process. In this respect, there might be competition from the petroleum industry in the case of some products.

See also abstract 3.6.

## 12. INDUSTRIAL USES. PRODUCTION OF MICROBIAL PROTEIN

### 12.1

Calle, H. ENSAYO SOBRE CULTIVO DE LEVADURAS ALIMENTICIAS EN PULPA DE CAFE. [A Study on the Growth of Nutritive Yeasts on Coffee Pulp]. *Boletín Informativo del Centro Nacional de Investigaciones de Café (Colombia)* 2(14): 33-36. 1951.

Since 39% of the ripe coffee berry is fresh pulp and 22% is mucilage, it is justifiable to look for means for the utilization of this great volume of waste materials. One such means is the production of alimentary yeasts. In order to use the maximum amount of the sugars present in coffee by-products it is necessary to depulp the coffee under "dry" conditions thus preventing the washing of the mucilage. Unwashed coffee pulp contains 1.57% sucrose, an essential component for nutritive yeast cultures. These organisms are pseudo yeasts represented by the families Rhodotorulacea, Torulopsidacea and Nectaromycetacea. Of these, the species *Torulopsis utilis* possesses outstanding nutritional properties, especially in regard to its high protein content including high levels of lysine, an amino acid commonly deficient in plant proteins. In addition to sucrose the culture medium would have to include a source of inorganic N and minerals. *Torulopsis* cultures will yield 100 g of dry yeast for every 500 g of air-dried coffee pulp which can be obtained from 15 kg of coffee berries. The percent of protein in this type of yeast is 50.4. The analysis of coffee pulp dried at 105°C revealed a dry matter content of 12.4%, crude fiber 3.8%, ashes 9.9%, ether extract 5.5%, total organic N 7.9% and total P 0.006%

### 12.2

Calle, H. LOS CONCENTRADOS DE PULPA Y DE MUCILAGO DEL CAFE. [The Concentrated Products Obtainable from Coffee Pulp and Mucilage]. *Boletín Informativo del Centro Nacional de Investigaciones de Café (Colombia)* 3(35): 22-30. 1952.

The main difficulties in the industrialization of coffee pulp and coffee mucilage, are the following: (1) their rapid rate of fermentation. (2) the total volume. (3) the high water content. (4) the scattered distribution of the production centers and (5) the treatment systems at the coffee processing plants. The initial fermentation which coffee pulp and mucilage undergo is at the expense of the

sugar content. The levels of fermentable sugars in coffee pulp and mucilage vary between 6 and 8%. Preservation of these carbohydrates may be achieved by treating the coffee pulp with gaseous SO<sub>2</sub> until the mass becomes yellow in color. Comparing SO<sub>2</sub>-treated material vs. untreated material it was found that the treated material conserved the sugars at least for the 8 days that comprised the test, while the untreated material lost its sugar contents by the fifth day. The level of sulfur used varied between 5 and 7 lb/ton of pulp. It is possible to obtain coffee molasses from the pulp and mucilage if the depulping process is realized without the use of water. One-hundred kg of coffee berries can produce 1.4 kg of molasses, with 42% reducing and inverted sugars, if only the pulp is used. If both pulp and mucilage are used, 100 kg of coffee berries can produce 6 kg of molasses containing 35% total sugars. The uses of coffee molasses may be similar to that of citrus molasses, i.e., in animal feeding, alcoholic fermentation, and in the production of yeasts. The extraction of sugars, proteins and pectins from the pulp can be achieved if the pulp is previously hydrolyzed with 1 to 5% sodium sulfite solutions. After cooling, the treated material will become a gelatinous colloid. The resulting jelly will contain 42% water and 9.9% protein.

### 12.3

*Calle, H. ESTADO ACTUAL DE LOS TRABAJOS SOBRE PROPAGACION DE MICROORGANISMOS ALIMENTICIOS EN PULPA Y MUCILAGO DEL CAFE. [Present State of the Investigations on the Propagation of Nutritive Microorganisms Using Coffee Pulp and Mucilage]. Boletín Informativo del Centro Nacional de Investigaciones del Café (Colombia) 5(50): 22-29. 1954.*

Several methods for the production of Torula yeast were described using coffee pulp juice, coffee mucilage juice or coffee pulp without extraction of juice. In any case, it is important to maintain sterile conditions so as to prevent contamination. Under controlled conditions, the organic nitrogen content of dry yeast was 6.18% when a continuous process was used, 6.53% when the yeast was harvested from foam and with application of 11.5-7.5-16.0 fertilizer. Due to infestation by other microorganisms the N content may go down to 5.49%. In general, the propagation of yeast on the coffee pulp itself, by the "floor process", results in lower N levels: 4.84 to 5.69%. The studies included other microorganisms such as *Rhodotorula* yeast (5.96% organic nitrogen), *Aspergillus oryzae*, and *B. megatherium*, with very promising results. In one specific study where the Torula culture was infested by another

type of yeast it was observed that the dry matter yield was the highest obtained in all the studies.

### 12.4

*Gómez Torres, E.A. LA LEVADURA TORULA OBTENIDA DE LA PULPA DE CAFE COMO FUENTE DE PROTEINA Y DE VITAMINAS PARA POLLOS DE ENGORDE. [Torula Yeast Obtained from Coffee Pulp as a Source of Protein and Vitamins for Broilers]. Thesis Ing. Agrónomo, University of Costa Rica. 1970. 86 p.*

Two hundred broilers were used with the purpose of evaluating the Torula yeast, produced from the coffee pulp, as a partial or total substitute for fish meal. It was found that the total substitution of fish meal had detrimental effects on the growth of the birds, while the substitution of 75% of fish meal by yeast had no undesirable effects. It was also found that this type of yeast is an excellent source of B-complex vitamins, when it is used at the minimum level of 6%. It was also found that Torula yeast, at any given level in the broiler ration, produced no adverse effects on the quality of the meat in terms of texture and flavor.

### 12.5

*Staudinger, W.L. A LABORATORY INVESTIGATION OF SOME AGRICULTURAL WASTE PRODUCTS FOR GROWTH OF CANDIDA UTILIS Turrialba 18(3): 234-241. 1968.*

The suitability of coffee bean pulp juice, coffee bean mucilage, banana stalk juice, cabuya leaf juice and tapa de dulce (crude cane sugar) as carbohydrate sources for growth of *Candida utilis* was investigated in the laboratory. Coffee pulp juice contains sufficient carbohydrates and inorganic elements to support growth of *C. utilis*. Coffee pulp juice extracted 2 hours after collection contained the highest reducing sugar level (2.5%), probably because of enzymatic hydrolysis of mucilage and carbohydrates by the yeast and bacteria present on the pulp surface. The relatively high numbers of bacterial contaminants normally inhabiting the coffee pulp surface probably precludes the fermentation of this material without prior sterilization and inoculation of the medium. Boiling SO<sub>2</sub>-treated pulp juice for 10 minutes rendered it available for growth of *C. utilis*. Coffee bean mucilage and banana stalk juice were not suitable substrates for growth of *C. utilis*; however, cabuya leaf juice and tapa de dulce were both excellent sources of carbon for this organism.

### 13. INDUSTRIAL USES. MANUFACTURE OF ALCOHOLS

#### 13.1

*Scharrer, R. CONTRIBUCION AL ESTUDIO DE LA FERMENTACION DEL CAFE. [A Contribution to the Study of Coffee Fermentation]. Revista Cafetera de Colombia 8(110): 2917-2924. 1942.*

This article outlines the principles of coffee mucilage fermentation and procedures are proposed so as to obtain a more rapid separation of the mucilage from the coffee grain by using yeast cultures, control of atmosphere, pressure and temperature. Coffee plantations provide natural strains of yeast of the *mycoderma* type. These can be easily isolated by washing the coffee berries in sterilized water. The author also considers a practical application of fermentation principles mainly by subjecting coffee pulp to distillary procedures whereby alcohol is obtained and the acidity of the material is neutralized which would render it more suitable as an organic fertilizer. To this effect, the material would have to be sterilized at first (to destroy mycoderma and acetic bacteria) and then inoculated with an alcohol producing yeast.

### 14. INDUSTRIAL USES. OTHER

#### 14.1

*Valencia A., G. and Calle V., H. LA MIEL DE CAFE Y SU COMPOSICION. [Coffee Molasses and its Composition]. Cenicafe (Colombia) 19(4): 135-139. 1968.*

Coffee molasses is obtained by depulping without water the coffee berries. The pulp is squeezed in a hydraulic press, the grains are washed by recycling water through them and then they are mixed with the pulp juice and finally boiled down to a concentrated mixture. It was found that the sugars present in the largest amounts in coffee molasses are fructose, glucose, sucrose and trace quantities of raffinose. Compared to sugar cane molasses, Coffee molasses contains higher quantities of glucose and fructose.

#### 14.2

*Valerio, L. CAFFE E DERIVATI. [Coffee and Derivatives]. Hoepli, Milano. 1927.*

Editor's note: The following abstract was obtained from the review by Barbera (abstract No. 11.2) and not from the original paper which was not available.

The possible uses of ground coffee, according to the author, are: 1) as a flower fertilizer which softens the soil, provides nitrogen and phosphorus, and keeps away some insects for a while, among these, the ants; 2) as a feed component for cattle, mixed with oil cakes and forage, not surpassing the proportion of 8-10% of the total feed; 3) as a deodorant product obtained by washing with hot water, drying at 100°C, washing with alcohol and finally drying at 170°C; and 4) as a carbon deodorant obtained by quick calcination in closed containers. A scheme for the complete utilization of the spent coffee grounds is also proposed. One of the products is a protein substance that the author calls "cafeoligumina" that can be used as a nutrient in rations.

### 15. PROCESSING METHODS

#### 15.1

*Carbonell, R.J. and Vilanova M., T. BENEFICIA-DO RAPIDO Y EFICIENTE DE CAFE MEDIANTE EL USO DE SODA CAUSTICA. [Fast and Efficient Curing of Coffee through the Use of Sodium Hydroxide]. El Cafe de El Salvador 22(248-249): 407-556. 1952.*

Different systems for coffee curing are discussed, stressing the shortcomings and advantages of each. Emphasis is placed on the need for developing better methods for coffee curing. A review of previous papers, dealing with both the wet and the dry curing methods, is included. Also included are theoretical discussions about the structure of the mucilage-like material of coffee berries and the different enzyme systems involved in the fermentation process. Experimental work done by the authors included: (a) study of the structure of the mucilage-like material of coffee berries; based on experimental data the authors concluded that the mucilage has no definite cell structure, as indicated by the lack of cell walls and by its conversion into

a sol upon heating and regeneration upon cooling; (b) search for a mucilage digesting agent; of various agents tested, sodium hydroxide (caustic soda) was selected as the most efficient; and (c) a study of the possibilities of using sodium hydroxide for coffee curing; the results showed that, by changing the concentration of the alkali, digestion could be accomplished almost at will, for any desired length of time ranging from 2 minutes to 1 hour; the results also showed that sodium hydroxide provides a means of digesting the mucilage much faster than by any other previously developed method, without having any deleterious effect upon coffee quality. Other studies included metabolic transformations in coffee, environmental effects on quality, operations in coffee processing plants, and coffee drying methods.

### 15.2

*Jarquín, R., Braham, J.E., González, J.M. and Bressani, R. UTILIZACION DE LA PULPA DE CAFE EN FORMA DE ENSILAJE. [The Utilization of Coffee Pulp in the Forma of Silage]. IV Meeting of ALPA(Latin American Association of Animal Production), México, Abstract R-26. 1973.*

Previous results have indicated that coffee pulp (CP) contains unidentified compounds that have physiologically adverse effects on ruminants. The purpose of this study was to try to identify these effects through possible changes in the bio-chemical composition of blood serum. Sixteen Holstein bull calves of 145 days of age and weighing an average or 144 kg were used. The control group was fed a basal ration containing 48% cotton hulls, 20% molasses, 15% cottonseed meal, 15% wheat bran, 1% urea, and 1% minerals. Of the remaining 3 groups one was fed a basal ration containing 30% fresh dried CP and the others were fed 30 or 48% dehydrated CP silage, substituting for the cotton hulls. The dehydrated silage contained 11.6% crude protein, 22.6% fiber, 9.6% minerals, 2.8% fat and 53.4% NFE. After 84 days, the animals were bled to determine the serum levels of protein, albumen, urea, nitrogen, Ca, glucose, P, glutamic-oxaloacetic transaminase, glutamic-pyruvic transaminase and free fatty acids. The gains in weight (kg/day) and the efficiency of feed utilization for the control group, 30% pulp (natural), 30%, and 48% pulp silage were: 1.37 and 7.9; 1.08 and 8.5; 0.94 and 9.0; and 0.83 and 8.8, respectively. There were no significant differences in the blood values among the groups, except for the free fatty acids, which were found significantly higher in the CP-fed groups. The lower weight gains and the lower feed efficiency obtained when CP is fed do

not justify discarding coffee pulp, which can be very well used at levels not higher than 20% of the ration.

### 15.3

*Rodríguez, J.A. EFECTO DE DIFERENTES PERIODOS DE EXPOSICION AMBIENTAL SOBRE LA PULPA DE CAFE Y CASCARA DE CACAO PREVIO A SU ENSILADO. [Effect of Different Periods of Exposure to Environment on the Quality of Coffee Pulp Silage and Cacao Pods Silage]. Thesis Ing. Agr. University of Costa Rica. 1973. 55 p.*

The objective of the experiment was to evaluate coffee pulp and cacao pod silages, with or without 3% molasses, prepared with materials previously exposed to outdoor environment for different periods of time. The silages were prepared during 4 consecutive days using fresh material and material one, two or three days after its harvesting. One-gallon (3.8 liters) microsilos were used in all trials. After 90 days, the silos were opened and samples were obtained to determine pH, % protein, % butyric acid, % acetic acid and milliequivalents/100 ml of total free aminoacids. Following this order, the results were as follows. Coffee pulp silage with molasses: 4.9, 9.9, 0.8, 1.2 and 36.1; coffee pulp silage without molasses: 4.8, 9.8, 0.6, 1.9 and 46.1. The protein content prior to ensiling was 10.0% and the content of dry matter prior to ensiling was 16.9%. This level of dry matter was nearly the same as that measured 90 days after ensiling: 16.6%. The contents of butyric acid and the pH levels are considered to be slightly high with respect to values commonly reported for other types of silage. Exposure to the environment had an adverse effect upon quality of silage. Addition of molasses did not improve the quality of coffee pulp silage but it had a favorable effect on cacao pod silage as the levels of pH and butyric acid decreased.

### 15.4

*Van Rest, D.J. and Randel, P.F. METHODS OF ENSILING COFFEE PULP. Transactions of the American Society of Agricultural Engineering 12(2): 180-181, 186. 1969.*

Coffee pulp can provide a competitive source of crude fiber for animal rations. Ensiling of small quantities is feasible in plastic sacks. For larger quantities, well-packed, polythene-sheet-covered trenches can be considered. Besides crude fiber, needed in ruminant rations, the resulting silage will supply some digestible nutrients of value to both ruminants and hogs. The palatability of the

material was found to be good in hogs and, given time for adjustment, would probably be good in calves also.

See also abstracts 3.3, 4.1, 4.2, 4.3, 8.13, 8.14, 8.15, 8.17, 8.20 and 9.8.

## 16. MISCELANEOUS

### 16.1

*Agate, A.D. and Bhat, J.V.* ROLE OF PECTINOLYTIC YEASTS IN THE DEGRADATION OF MUCILAGE LAYER OF *COFFEA ROBUSTA* CHERRIES. *Applied Microbiology* 14(2): 256-260. 1966.

*Pectinolytic yeasts, Saccharomyces marxianus, S. bayanus, S. cerevisias var. ellipsoideus, and Schizosaccharomyces sp.,* predominated in the natural fermentation of coffee cherries of *Coffea robusta* variety grown in Chikmagalu district of Mysore State, India. These yeast species were found on the cherry surfaces, and evidence was adduced to show that the natural fermentation of coffee was the result of activity of microflora from the cherry surface itself rather than that of flora of air or water. Incorporation of pure cultures of *Saccharomyces* species was shown to aid the process when a mixture of all three species was used. An enzyme preparation from the *Saccharomyces* species was observed to hasten the mucilage-layer degradation.

### 16.2

*Frank, H.A., Lum, N.A. and De la Cruz, A.S.* Bacteria Responsible for Mucilage-Layer Decomposition in Kona Coffee Cherries. *Applied Microbiology* 13(2): 201-207. 1965.

The predominant microbial flora present during decomposition of the mucilage layer of Kona (Hawaii) coffee cherries were gram-negative bacteria which fermented lactose rapidly. Cultures

isolated from coffee cherries undergoing fermentation included species of *Erwinia*, *Paracolobactrum*, and *Escherichia*. Unblemished cherry surfaces and coffee plantation soil also had a microflora containing a high proportion of bacteria belonging to these three genera. Of 168 isolates tested, the 44 strains capable of demucilaging depulped coffee cherries were all members of *Erwinia dissolvens*. Supernatant growth medium liquids, after removal of *E. dissolvens* cells, actively decomposed the mucilage layer of depulped cherries.

### 16.3

*Sylvain, P.G.* EL PROBLEMA DEL CONTENIDO DE CAFEINA EN EL CAFE. [The Problem of Caffeine Content in Coffee]. *Café (Perú)* 8(3): 2-11. 1967.

According to the author, coffee has always been considered by many people including physicians, as harmful to good health. Caffeine is generally blamed for this so-called "coffee effect" although other components of the product may be of importance in this respect. The author suggests a series of investigations to be carried out with the purpose of obtaining a high quality coffee devoid of caffeine and, under all aspects, acceptable to the medical profession. Mention is made of species which bear seeds without caffeine or with a very small amount of the alkaloid, for instance the majority of species from Madagascar and the Mascarene Islands. The investigations suggested include: selection of progenies of *C. arabica* with a low caffeine content, inheritance studies, agronomic and organoleptic studies of *C. mauritiana*, *C. macrocarpa*, and *C. campaniensis*, hybridization of low caffeine progenies with high yielding types of good quality, and other studies.

### 16.4

*Wilson, W.K.* COFFEE GROUNDS IN ANIMAL RATIONS. *Nature (London)* 149 (3778): 361-362. 1942.

Coffee grounds were not relished. Ten rabbits fed a diet containing 10% coffee grounds were inferior to 10 controls in weight, fur production, reproduction and also developed minor neuritic symptoms.



## 17. SUBJECT INDEX

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