Allantoin in shea kernel

J. K. B. A. ATA & D. FEJER

(J.K.B.A.A.: Food Research Institute, P.O. Box M-20, Accra; D.F.: Department of Nutrition and Food Science, University of Ghana, Legon)

SUMMARY

The level of allantoin and its intermediary products in water extract of defatted shea kernel meal have been investigated. The results have shown that allantoin and its products constitute 24–28% of the total N of the extract.

Original scientific paper. Received 19 Nov 74; revised 18 Jul 75.

RÉSUMÉ

ATA J. K. B. A. & FEJER, D.: *L'allantoine dans les graines de karité.* Les auteurs ont étudié le taux d'allantoine et de ses produits intermédiaires dans des extraits aqueux de farine de graines dégraissées de karité. Les résultats ont montré que l'allantoine et ses produits dérivés constituent 24-28% de l'azote total de ces extraits.

Introduction

Much information is available concerning the constituents of shea fat (obtained from the plant *Butyrospermum parkii* G. Don Kotschy). Irvine, Laurie, McNab & Spring (1956) categorized the constituents as triglycerides, phytosterols, latex and resins. These constituents have been studied further by many, including Heilbron, Moffat & Spring (1934); Beynon, Heilbron & Spring (1937); Seitz & Jeger (1949); Dawson, Halsall, Jones & Robins (1953); Aage Jart (1959); Coleman (1961); and Hilditch & Williams (1964). However, little information is available on the non-fatty constituents of the kernel.

The work of Ruyssen (1957) showed that the crude protein content (N×6·25) of the whole kernel was about 7%. This has been confirmed in an analytical study on kernels obtained in Ghana (unpublished data). Other analytical results in Ghana showed that only about 50% of the total N was of protein origin and 25% of low molecular weight peptides.

Allantoin and allantoic acid are two ureides of glyoxylic acid commonly found in living organisms and shown to be present in plants by Tracey (1955). It has been reported by Sartorrus, Mothes & Engelbrecht (1954) that the leaves of *Acer negunde*, Linn. derive 25% of the total N from allantoin. Similarly, allantoin N in the floral axes of *Wisteria sinensis* (Sims) Sweet is 27%; it is 45% in the floral axes of *Acer pseudoplantanus* Linn. and 70% in the roots of *Symphytum officinale* Linn. The metabolic relationship of allantoin and other N compounds in plants is illustrated in Fig. 1.

This study was, therefore, conducted to determine allantoin and its intermediary compounds in shea kernel.

Materials and methods

Among the methods for the determination of allantoin are those of Borsook (1935), Florkin & Duchateau-Bosson (1940), Young & Conway (1942), Young, MacPherson, Wentworth & Hawkins (1944) and Dudzik (1969).

The basic reaction as shown by Allen & Cerecedo (1931) is based on the conversion of allantoin to allantoic acid, which is further hydrolyzed to glyoxylic acid and urea. Further coupling of the glyoxylic acid with phenylhydrazine hydrochloride and the oxidation of the hydrazone in strong acid medium with potassium ferricyanide produce a coloured product, 1, 5-diphenylformazan, as shown by Christman, Foster & Esterers (1944) and Matsui, Okada & Ishidale (1965). Vogels & Van der Drifts (1970) improved on this method to obtain a differentiating analysis for glyoxylate derivatives to within 2% accuracy.

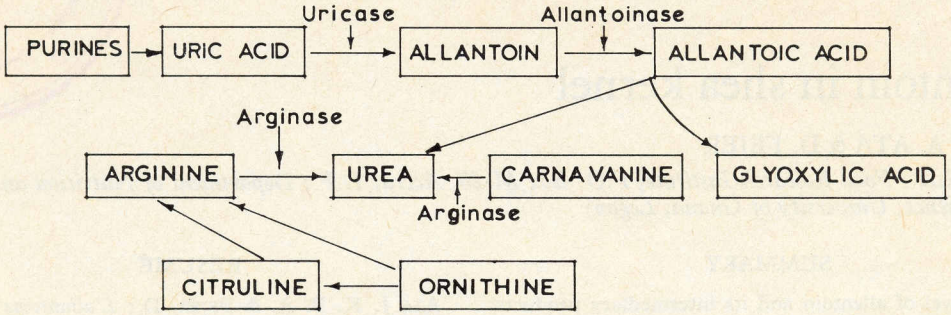

Fig. 1. Metabolic relationship of allantoin and other nitrogen compounds in plants.

The method of Vogels & Van der Drift (1970) was used in this study.

Standard analysis

Four cm^3 of the shea meal extract (5·67 of defatted shea meal extracted three times with water and the volume of filtrates made to 100 cm^3) were made up to 5 cm^3 with water. One cm^3 phosphate buffer (0·4*M*Na_2HPO_4, *p*H 7·0) and 1 cm^3 of phenylhydrazine hydrochloride solution (100 mg in 30 cm^3 water) were added. The tubes were placed at room temperature for 15 min and the colour measured in an Optica Milano CF4 spectrophotometer at 535 nm.

Alkali hydrolysis of ureidoglycolate

One cm^3 of the shea meal extract was mixed with 1 cm^3 of 0·5 *N* sodium hydroxide and allowed to stand at room temperature for 2 min. Four cm^3 of phosphate buffer and 1 cm^3 of phenylhydrazine hydrochloride solution were added and the standard analysis applied.

Heat hydrolysis of ureidoglycolate

One cm^3 of the shea meal extract was mixed with 1 cm^3 of phosphate buffer and heated at 100°C for 10 min. After cooling, 4 cm^3 water and 1 cm^3 phenylhydrazine hydrochloride solution were added and the standard analysis applied.

Acid hydrolysis of allantoate

One cm^3 of the shea meal extract was mixed with 3 cm^3 water and 1 cm^3 0·15 *N* hydrochloric acid and heated at 100°C for 5 min. After cooling, 1 cm^3 of phosphate buffer and 1 cm^3 of phenylhydrazine hydrochloride solution were added and the standard analysis applied.

Alkali-acid hydrolysis of allantoin

One cm^3 of the shea meal extract was mixed with 2 cm^3 water and 1 cm^3 of 0·5 *N* sodium hydroxide and heated at 100°C for 10 min. After cooling, 1 cm^3 of 0·65 *N* hydrochloric acid was added and the mixture again heated at 100°C for 5 min. One cm^3 of phosphate buffer and 1 cm^3 phynylhydrazine solution were added to the cold mixture and the standard analysis applied.

Additional mixture was analysed using the above method, except that one drop of phenyhydrazine hydrochloride was added together with 1 cm^3 of 0·5 *N* sodium hydroxide.

Alkali-acid hydrolysis of pure allantoin

2·68 g pure allantoin prepared from uric acid was dissolved in 25 cm^3 water and treated in the same manner as the shea meal extract and then hydrolyzed as above. The objective of using pure allantoin was to establish the accuracy of the method and, also, to determine the necessary correction factors applicable to the sample.

Results and discussion

The derivatives obtained with each modification in the analysis by the method of Vogel & Van der Drift (1970) and the results obtained by spectrophotometry are presented in Table 1.

Alkali-acid hydrolysis of allantoin gave results which showed the presence of glyoxylic acid and other intermediary products. A more accurate figure for the contribution of allantoin and its hydrolysis products to the total nitrogen was calculated based on the spectrophotometric reading, as presented in Table 1. Pure allantoin, was used to establish the accuracy of this method.

TABLE 1

Derivatives Determined by the Method of Vogels & Van der Drift (1970)

Method	*Glyoxylate*	*Ureidoglycolate*	*Allantoate*	*Allantoin*	*Reading at 535 nm*
Standard analysis (SA)	+	−	−	−	0·119
SA preceded by alkali hydrolysis	+	+	−	−	0·154
SA preceded by heat hydrolysis	+	+	(−)*	−	0·171
SA preceded by acid hydrolysis	+	+	+	−	0·158
SA preceded by alkali-acid hydrolysis	+	+	+	+	0·297
Phenyl hydrazine method	−	−	+	+	0·268
Alkali-acid hydrolysis of pure allantoin	+	+	+	+	0·208

*2·9% of the allantoate present acted positively.

TABLE 2

Calculated Allantoin Content of Five Batches of Shea Kernel

Batch No.	*N due to allantoin (%)*
1	27·89
2	25·64
3	26·30
4	24·33
5	28·41
Mean	26·49

Table 2 shows the results of repeated determinations of allantoin in five different batches of shea meal. Nitrogen of the shea kernel due to allantoin and its intermediate products was found to vary from 24% to 28%.

The results have shown that about 24–28% of the Kjeldahl N is obtained from allantoin and its intermediary products. From the point of view of the use of shea cake in animal feed formulations, the information has provided a basis for a re-examination of results based on total N determinations. The presence of allantoin has also opened the way for a consideration of the use of shea kernels in the pharmaceutical industry, especially due to the keratolytic and humeotant properties of allantoin.

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