

Effect of fermentation and germination on the *in vitro* protein digestibility of low and high tannin cultivars of sorghum

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Three sorghum cultivars, safra, dabar 1–1 (low in tannin: 0.61 and 0.24%, respectively) and cross 35:18 (high in tannin: 1.10%) obtained from Wad Medani Research Station were used in this study. Safra and cross 35:18 were fermented for 14 h and then the protein was fractionated and the IVPDs of the fractions were determined at 2 h intervals. The IVPD of the protein fractions of the low tannin cultivar increased due to the effect of fermentation and, in the case of the high tannin sorghum cultivar, it increased during the first 6 h of fermentation for the albumin, globulin and prolamin; then it decreased in the remaining period of fermentation. The IVPD of the glutelin fraction increased during the last 6 h of fermentation. Dabar 1–1 and cross 35:18 cultivars were soaked in water for 10 and 20 h and germinated for 72 h. The protein was fractionated every 24 h and the IVPDs of the fractions were determined. For the low tannin cultivar, the IVPDs of the fractions albumin, globulin and glutelin increased, but the IVPD of the prolamin fraction decreased when the grains were soaked for 10 h. When the grains were soaked for 20 h, the IVPD of the fractions albumin, prolamin and glutelin increased, but the IVPD of the globulin fraction decreased. In the case of the high tannin cultivar, the IVPD decreased for all fractions except for the prolamin fraction when the grains were soaked for 10 h.

INTRODUCTION

Grain sorghum is a staple food for people in Africa and India. The nutritive value of food sorghum is low due to the presence of tannins which form a complex with proteins and reduce their digestibility (Bhise *et al.*, 1988). Low digestibility is a major nutritional problem in high tannin sorghum cultivars, whose protein digestibility for different animal species varies from 30 to 80% depending upon the tannin content (PAG Compendium, 1975).

Fermentation and germination have equivalent effects in improving the protein quality of cereals (Hamad & Fields, 1979). This study reports the effects of fermentation and germination on the *in vitro* protein digestibility (IVPD) of the protein fractions of low and high tannin cultivars of sorghum.

MATERIALS AND METHODS

Materials

Three sorghum cultivars, namely, dabar 1–1, safra, and cross 35:18 were obtained from Wad Medani Research

Station. Clean samples of safra and cross 35:18 cultivars were used for fermentation. The grains were milled into fine flour to pass a 0.4 mm screen. Dabar 1–1 and cross 35:18 cultivars were used for germination.

Fermentation of samples

Fermented dough was prepared in the traditional way as described by El Tinay *et al.* (1979). Samples were taken at 2 h intervals until the end of fermentation which was terminated after 14 h (pH 3.8–3.9).

Germination of samples

The germination of sorghum was carried out according to the method of Bhise *et al.* (1988). The germinated grains were dried to constant weight at 70°C. The root portions were manually removed. The grains were milled into fine flour (0.4 mm).

Fractionation of protein

The Mendel–Osborne (1914) technique for protein fractionation was used in this study.

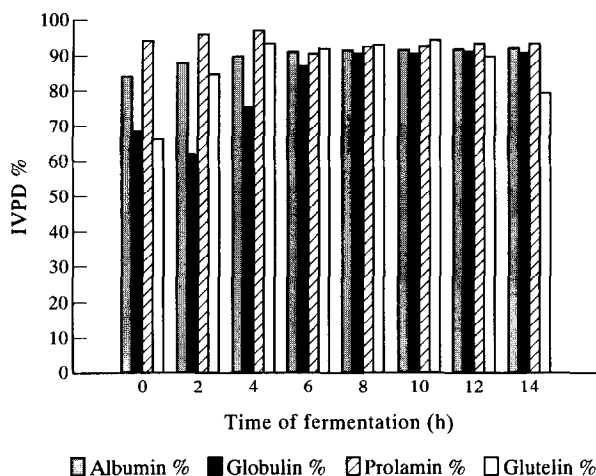


Fig. 1. Effect of fermentation on IVPD of protein fractions of sorghum cultivar safra.

In vitro protein digestibility with pepsin

In vitro protein digestibility (IVPD) was carried out by the method of Maliwal (1983) as modified by Manjula and John (1991).

Determination of tannin content

Tannins were estimated by the modified procedure of Maxon and Rooney as described by Price *et al.* (1978).

Statistical analysis

Each sample was analyzed in triplicate and the figures were then averaged. Data were assessed by analysis of variance (ANOVA) (Snedecor & Cochran, 1987) and by the Duncan multiple range test with a probability $P \leq 0.05$ (Duncan, 1955).

RESULTS AND DISCUSSION

Figure 1 shows the effect of fermentation on the IVPD of protein fractions of the fermented sorghum cultivar safra. The IVPD of the albumin fraction increased significantly ($P \leq 0.05$) with fermentation; while the IVPD of the globulin fraction decreased in the first 2 h of fermentation, this decrease may be due to a decrease in the protein content of this fraction which leads to a decrease of the IVPD. The IVPD started to increase until it reached its maximum value after 12 h of fermentation. The IVPD of the glutelin fraction increased significantly ($P \leq 0.05$) in the first 4 h of fermentation; then it fluctuated during the remaining period. Romo-Parada *et al.* (1985) reported that controlled fermentation decreased the IVPD of a low tannin sorghum cultivar by 6.3%. Cummins (1971) reported an increase in the IVPD of a low tannin sorghum cultivar of 7.7%.

Figure 2 shows the effect of fermentation on the IVPD of the protein fractions of sorghum cultivar cross 35:18. The IVPD of the globulin fraction increased significantly

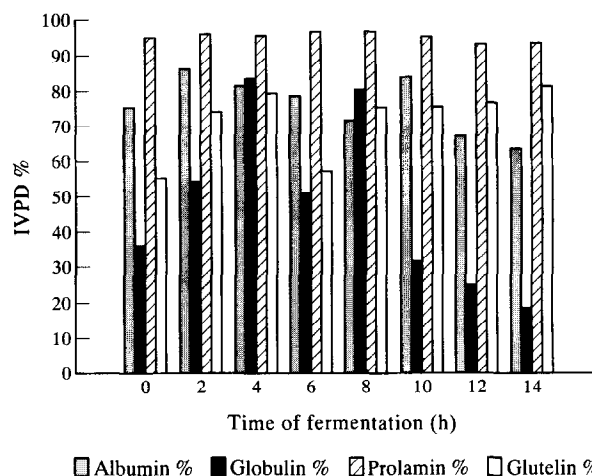


Fig. 2. Effect of fermentation on IVPD of protein fractions of sorghum cultivar cross 35:18.

($P \leq 0.05$) in the first 4 h of fermentation, then it decreased significantly ($P \leq 0.05$) for the remaining period of fermentation. For the glutelin fraction, the IVPD increased during the first 4 h of fermentation, then it decreased after 6 h and started to increase reaching a maximum value (81%) at the end of the fermentation.

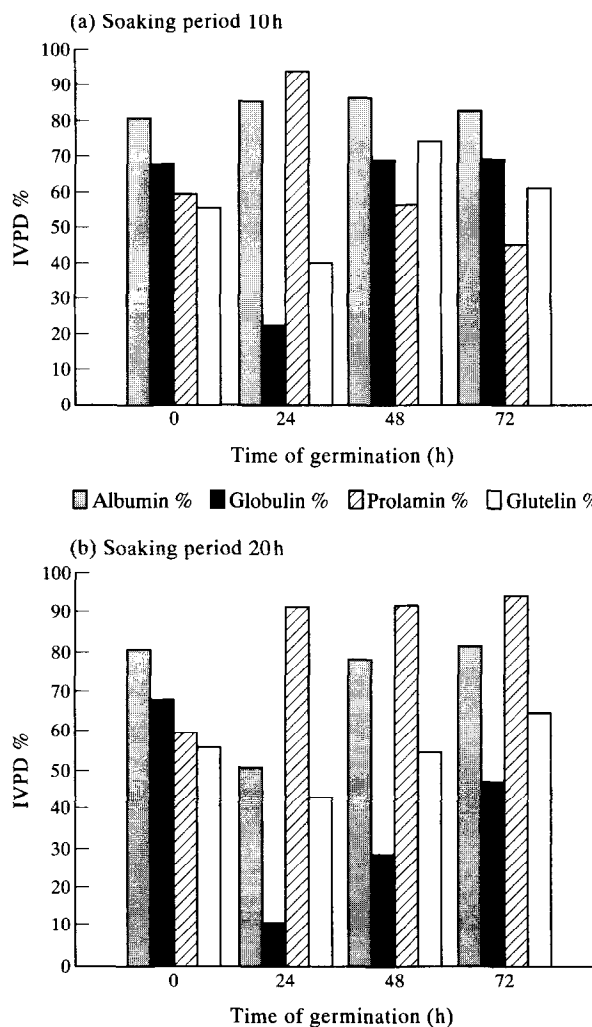


Fig. 3. Effect of germination on IVPD of protein fractions of sorghum cultivar dabar 1-1.

Romo-Parada *et al.* (1985) reported that controlled fermentation increased the IVPD of a high tannin sorghum cultivar by 17.5%, and natural fermentation increased it by 25.6%. Cummins (1971) reported an increase of IVPD of a high tannin sorghum cultivar by 36%. Chavan *et al.* (1988) found that the IVPD of sorghum grain increased markedly by fermentation for 24 h.

Germination and IVPD of the fractions

Figure 3(a) shows the IVPD of the protein fractions of germinated sorghum cultivar dabar 1-1 when soaked for 10 h. The IVPD of the albumin fraction increased as the germination process progressed, but the increase was not significant. The IVPD of the globulin fraction decreased significantly ($P \leq 0.05$) in the first day of germination, then it increased slightly in the second day of germination and was the same in the third day. The IVPD of the prolamin fraction increased in the first day of germination by more than 50%, then it decreased during the following two days reaching its minimum value on the third day. The IVPD of the glutelin fraction fluctuated during germination.

Figure 3(b) shows the IVPD of the protein fractions of germinated dabar 1-1 when soaked for 20 h. The

IVPD of the albumin fraction fluctuated during the germination process. For the globulin fraction, the IVPD decreased significantly ($P \leq 0.05$) with germination, showing a minimum value in the first day of germination. In the case of the prolamin fraction, the IVPD increased by more than 50% in the third day of germination. The glutelin fraction IVPD decreased significantly ($P \leq 0.05$) in the first day of germination, then it increased during the last two days.

The IVPD of all fractions increased except for the prolamin and globulin when the grains were soaked for 10 and 20 h, respectively. This increase in the IVPD may be due to the degradation of proteins into amino acids by the action of enzymes produced during germination (Romo-Parada *et al.*, 1985). This indicated that soaking grains for 10 h and germination for three days is better than soaking for 20 h and germination for three days because the more important protein fractions having high IVPD were retained. Bhise *et al.* (1988) reported that the IVPD increased significantly when sorghum grains were soaked for 10 h followed by germination up to three days; an increase in the steeping period to 20 h or 30 h seemed to nullify this effect. This seems to agree with our results.

Figure 4(a) shows the IVPD of the protein fractions of germinated sorghum cultivar cross 35:18 when the grains were soaked for 10 h. The IVPD of the albumin fraction increased in the first day of germination, then it decreased in the following two days. The IVPD of the globulin fraction decreased significantly ($P \leq 0.05$) reaching its minimum value (2.6%) after 72 h of germination. The IVPD of the prolamin fraction increased as germination progressed, but the increase was not significant. The IVPD of the glutelin fraction decreased with germination.

The IVPD of protein fractions of germinated sorghum cultivar cross 35:18 when the grains were soaked for 20 h is shown in Fig. 4(b). The IVPD of the albumin and prolamin fractions increased in the first two days of germination, but the increase was not significant. The IVPD of these fractions decreased during the third day of germination. The IVPD of the globulin fraction decreased significantly ($P \leq 0.05$) having its minimum value (3.4%) in the last day of germination. The IVPD of the glutelin fraction decreased with germination having its minimum value (11.4%) in the last day of germination.

The results indicate that there is a decrease in the IVPD for all fractions except the prolamin fraction after 10 h soaking. This low IVPD could be attributed to protein-tannin interactions as these fractions are rich in tannin (El Khalifa & El Tinay, 1994). These results do not agree with Romo-Parada *et al.* (1985) who reported that germination increased the IVPD of low and high tannin sorghum cultivars. This may be due to the fact that they used multienzyme preparations, while in this study only pepsin has been used.

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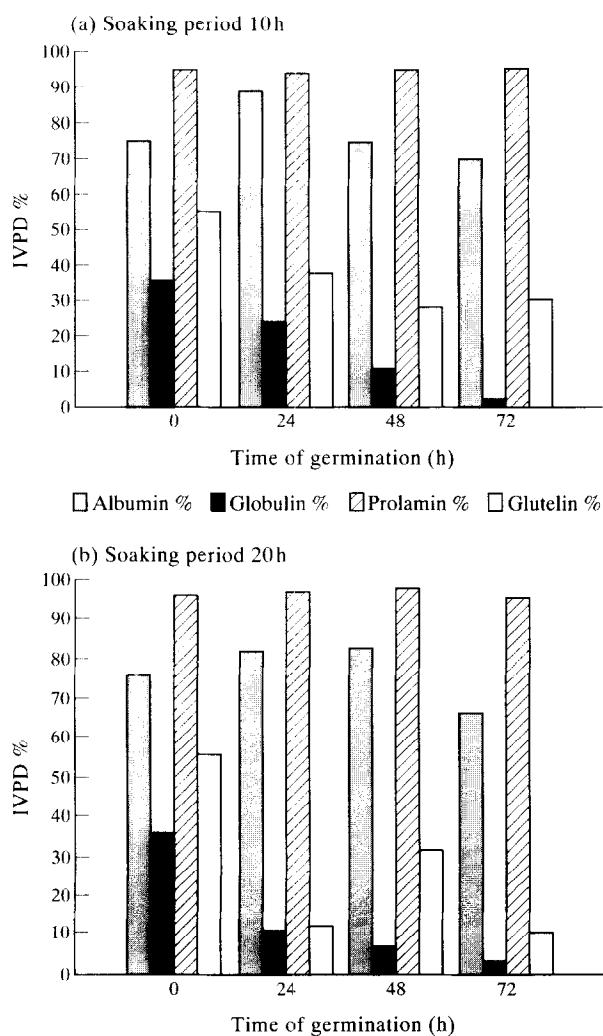


Fig. 4. Effect of germination on IVPD of protein fractions of sorghum cultivar cross 35:18.

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