Peñalver, Carolina; Herrera, Irma M.; Tovar, Juscelino
Indigestible starch associated to dietary fiber residues from cooked legume seeds consumed in Venezuela
Interciencia, vol. 32, núm. 9, septiembre, 2007, pp. 620-623
Asociación Interciencia
Caracas, Venezuela

Available in: http://www.redalyc.org/articulo.oa?id=33932908
INDIGESTIBLE STARCH ASSOCIATED TO DIETARY FIBER
RESIDUES FROM COOKED LEGUME SEEDS CONSUMED IN VENEZUELA

Carolina Peñalver, Irma M. Herrera and Juscelino Tovar

SUMMARY

Dietary fiber residues were prepared from the cooked seeds of eleven legume varieties, following the AOAC enzymatic method. Resistant starch associated to fiber, i.e. retrograded resistant starch (RS), was assessed after alkaline dispersion of the indigestible residues. All legumes contained significant amounts of RS, ranging between 3.0% (g per 100g cooked seed on dry matter basis) in red cowpeas and 7.2% in green peas. RS contents fell within a narrow interval (5.1 to 6.7%). Chick peas also exhibited substantial indigestible starch levels (6.7%). Employing previously reported dietary fiber values, RS levels recorded for each legume were used to calculate starch-corrected insoluble dietary fiber. Corrected figures were 11 to 38% lower than original values.

ALMIDÓN RESISTENTE ASOCIADO AL RESIDUO FIBROSO DE SEMILLAS DE LEGUMBRES COCIDAS CONSUMIDAS EN VENEZUELA

Carolina Peñalver, Irma M. Herrera y Juscelino Tovar

RESUMEN

El residuo fibroso de las semillas cocidas de once variedades de leguminosas comestibles fue preparado empleando el procedimiento enzimático de la AOAC. Una vez sometidos a un tratamiento de dispersión alcalina, dichos residuos fueron evaluados para determinar su contenido de almidón, que corresponde a fracciones de almidón resistente retrogradado (AR). Todas las leguminosas presentaron cantidades apreciables de AR, cuyos valores variaron entre 3.0% (g por 100g de semilla cocida en base seca), encontrado para el frijol caupí, y 7.2% para las arvejas verdes. El tenor de AR difirió muy poco entre las cuatro variedades de frijol común (Phaseolus vulgaris) analizadas (5,1-6.7%). El garbanzo también presentó valores considerables de AR (6.7%). Los tenores de AR se utilizaron para calcular el contenido de fibra dietética corregido, tomando como base valores de contenido de fibra insoluble descritos previamente para estas leguminosas. Dichos contenidos corregidos resultaron 11 a 38% menores que los valores originales.

Introduction

The definition of fiber has changed since the recognition of an indigestible portion in foods of plant origin. Thus, terms like crude fiber, roughage and, more recently, dietary fiber have appeared in the literature as the analysis of the indigestible portion of foods evolved (Asp, 1996; Saura-Calixto et al., 2000; McCleary, 2003). As a matter of fact, it has been extremely difficult to obtain an undisputed definition for dietary fiber (Cho and Proskey, 1999; Saura-Calixto et al., 2000), although some proposals hold manifest approval (Proskey et al., 1988; McCleary, 2003). One recent issue relates to the inclusion of the indigestible starch fraction of foods as dietary fiber (Champ et al., 2003; Sajilata et al., 2006; Tovar et al., 2006).

Indigestible, or resistant starch (RS) is defined as the sum of starch plus starch degradation products not absorbed in the small intestine of healthy individuals (Asp, 1992). Because of its indigestible character, RS may be regarded as dietary fiber (Champ et al., 2003; McCleary, 2003), although it does not make part of plant cell walls. In addition to a number of physiological motivations, the possible acceptance of RS as fiber is supported by the frequent occurrence of indigestible starch in dietary fiber residues prepared by enzymatic means (Johansson et al., 1984; Saura-Calixto et al., 1993; Tovar et al., 2002; McCleary, 2003). Actually, the first definition of RS was introduced to describe the presence of α-glucans in the dietary fiber fraction of heat-treated starchy foods (Englyst et al., 1982). It is now known that RS associated to dietary fiber residues is only a part of the total indigestible starch occurring in foods (Englyst et al., 1992; Champ et al., 2003) and corresponds to firmly retrograded starch.

KEYWORDS / Beans / Dietary Fiber / Legumes / Resistant Starch / Retrograded Starch /

Received: 01/18/2007. Accepted: 08/08/2007.


Irma M. Herrera. Biologist and MSc., UCV. Researcher, Instituto Nacional de Nutrición, Venezuela.

Juscelino Tovar. Biologist, UCV. Ph.D., University of Lund, Sweden. Professor, UCV. Address: Instituto de Biología Experimental, UCV. Apartado 47069, Caracas 1041A, Venezuela. email: jtovar@ciens.ucv.ve
fractions arising upon cooling and storage of gelatinized starch or cooked starch-containing food items (Saura-Calixto et al., 1993; Fredriksson, et al., 2000). Due to its physicochemical characteristics, amylase is the main responsible for the formation of retrograded RS (Siljeström et al., 1989), whereas the role of amylopectin in this process is controversial (Fredriksson et al., 2000).

Even if RS is to be included as part of dietary fiber, it may be still advantageous to know the exact contribution of the former to whole fiber contents (McCleary, 2003), particularly when dealing with foods whose starch constituents have significant retrogradation proclivity, such as legume seeds (Tovar et al., 1990a, b, 2002). In this study, cooked seeds from 11 different legumes consumed in Venezuela were analyzed for starch remnants in dietary fiber residues prepared with the enzymatic protocol of Prosky et al. (1988). Such figures may be employed to calculate starch-corrected dietary fiber values for these edible pulses.

Materials and Methods

The following legume seeds were analyzed: lentils (Lens culinaris L), green and yellow peas (Pisum sativum L), white and red cowpeas (Vigna sinensis L), chickpeas (Cicer arietinum L), pigeon peas (Cajanus cajan L Mills), and black, white, red and kidney beans (Phaseolus vulgaris L). All samples were purchased from a local market (Caracas, Venezuela). Since commercially available dehulled green and yellow peas are often consumed in Venezuela, these coat-free seeds were also evaluated.

Seeds were processed as in a previous study of dietary fiber in Venezuelan pulses (Herrera et al., 1998). In brief, seeds were washed and wetted in water (2h; room temperature; 4:1 water:seed ratio, v/w). The water/seed mixture was then boiled for 2h with liquid reposition as needed. After cooling to room temperature, cooked seeds were drained, dried under forced-air convection (25°C) and milled (60 mesh). Dehulled peas were boiled for 1h and dried/milled without draining (Herrera et al., 1998).

Insoluble dietary fiber residues were prepared in duplicate for each legume, following the enzymatic method of Prosky et al. (1988), the same protocol employed in the study by Herrera et al. (1998). Fiber residues were analyzed enzymatically for starch remnants, i.e. resistant starch, previous dispersion of the indigestible residue/celite mixture in 2N KOH (Johansson et al., 1984; Tovar et al., 1990a; Sambucetti and Zuleta, 1996). Results from the two residues were averaged and expressed as resistant starch (g) per 100 g cooked seed (dry matter basis).

Results and Discussion

Starch fractions remaining in dietary fiber residues prepared by enzymatic means consist of firmly retrograded α-glucan chains not susceptible to amylolytic attack (Siljeström et al., 1988; Saura-Calixto et al., 1993; Champ et al., 2003). Such an indigestible portion is called type 3 RS, according to the classification proposed by Englyst et al. (1992). As shown in Table I, all of the samples contained appreciable amounts of fiber-associated RS, whose levels varied between 3.0 and 7.2% (dbm). This finding is not surprising since starch in leguminous seeds has been shown to have a marked tendency to retrograde, thus generating indigestible material (Tovar et al., 2002) in proportions that surpass levels commonly found, for instance, in boiled roots and tubers (Blanco-Metzler et al., 2004), bread (Johansson et al., 1984) and other cereal products (Saura-Calixto et al., 1993; Sambucetti and Zuleta, 1996).

Compared to RS3 data re-
ported previously for other pulses, present values are
in the same order as those found in red and brown
beans (Tovar et al., 1990a, b), cowpeas (Velazco et al.,
1997) and black beans (Vargas-Torres et al., 2004).
The highest RS level was recorded in green peas (Ta-
ble I), while the two cowpea cultivars exhibited the
lowest concentrations. It is noteworthy that RS contents
in the four common bean (Phaseolus vulgaris) variet-
ies analyzed fell within a narrow interval (5.1-6.7%).

In addition to being good sources of protein, starch
and dietary fiber, pulses are also regarded as functional
foods, whose indigestible components may have a
number of health-benefi-
cial effects (Duranti, 2006). Functional features of the indigestible components of foods mainly depend on
their fermentability (Nyman, 2003). Different dietary fi-
bbers may be fermented to different extents, depending
on the botanical source and processing conditions (Asp
et al., 1993). Similarly, not all resistant starches are
fermented equally; for in-
stance, indigestible starch in common beans is fer-
mented in the rat gut to a
larger extent than lentil RS
(Tovar et al., 1992). More-
over, fiber and RS may also
exhibit different fermenta-
tion product patterns (Ny-
man, 2003). Hence, in spite of the current tendency to
integrate all indigestible fractions to the dietary fi-
ber concept (Saura-Calixto et al., 2000; Sajilata et al.,
2006) it is yet advisable to
know the composition of the
indigestible portion in a
particular food (McCleany,
2003; Gordon, 2007). Fiber-
associated RS contents may
be subtracted from insoluble
dietary fiber (IDF) in order
to calculate the starch-cor-
rected IDF (Tovar et al.,
1990a; Sambucetti and Zu-
leta, 1996). With this aim,
data reported by Herrera et al. (1998), who analyzed the
IDF content of cooked sam-
ples of the legumes studied
here was used. Corrected
IDF contents (g) ranged
between 11.6 and 24.0% (dmb), which are substan-
tially lower than the uncor-
rected fiber levels (16.4-
27%).

The most evident changes
recorded after correcting IDF values involved red
cowpea, black bean and pi-
gen pea. The former ex-
hibited 1% (dmb) more IDF
than black beans and al-
most 3% more than pigeon
pea, whereas corrected IDF values revealed equivalent
contents for black bean and pigeon pea (~20%), which
was 4% lower than in red
cowpea. Also, despite the
similar IDF content in yel-
low and green peas, their
corrected IDF figures were
considerably different.

Conclusions
Cooked seeds from eleven legume varieties consumed
in Venezuela were evaluated for dietary fiber-associated
resistant starch, i.e. type 3
RS. All of the samples con-
tained appreciable amounts of RS, ranging between 3
and 7.2% (dmb). RS con-
tenits were subtracted from
previously reported insol-
uble dietary fiber values in
order to obtain starch-cor-
corrected IDF contents, which
may be valuable for food labeling, dietetic and physi-
ological purposes.

ACKNOWLEDGMENTS
The authors acknowledge the financial support from
the International Foundation for Science (IFS-Grant E-
2009/3, Stockholm, Sweden)
and LANFOODS (Quito, Ecuador).

REFERENCES
pl. 2): 1.
Asp N-G (1996) Dietary carbo-
hydrates: Classification by
Asp N-G, Björck I, Nyman M
(1993) Physiological effects
of cereal dietary fiber. Carbo-
Blanco-Metzler A, Tovar J,
Caracterización nutricional de los carbohidratos y com-
posición centesimal de raíces
y tubérculos tropicales co-
cidados, cultivados en Costa
54: 322-327.
Champ M, Langkilde AM,
Brouns F, Kettlitz B, Be-

Bail Collet Y (2003) Ad-
vances in dietary fibre char-
acterization. 1. Definition of
dietary fibre, physiological
relevance, health benefits
and analytical aspects. Nutr.
Res. Rev. 16: 71-82.
Cho SS, Prosky L (1999) Com-
plex carbohydrates: defini-
tion and analysis. In Cho SS,
Prosky L, Dreher M (Eds.)
Complex Carbohydrates in
Foods. Dekker. New York,
USA, pp. 131-143.
Duranti M (2006) Grain legume
proteins and nutraceutical
products. Fitoterapia 77:
67-82.
Englyst HN, Wiggins HS, Cum-
nings JH (1992) Determina-
tion of the non-starch poly-
saccharides in plant foods by
gas-liquid chromatography
of constituent sugars as al-
ditol acetates. Analyst 107:
307-318.
Englyst HN, Kingman SM, Cum-
nings JH (1992) Classifica-
tion and measurement of nu-
tritionally important starch
46 (Suppl. 2): S33-S50.
Fredriksson H, Björck I, Anders-
son R, Lijeborg H, Silve-
rio J, Eliasson AC, Aman P
(2000) Studies on alpha-
amylase degradation of re-
regroded starch gels from
waxy maize and high-amy-
lopectin potato. Carbohydr.
Polym. 45: 81-87.
Gordon DT (2007) Dietary fiber
definitions at risk. Cereal
Foods World 52: 112-123.
Herrera IM, González EP, Rome-
ro J (1998) Fibra dietética
soluble, insoluble y total en
leguminosas crudas y cocid-
48: 179-182.
Johansson CG, Siljeström M, Asp
in bread and corresponding
flours - Formación de resis-
tant starch. Z. Lebensm.
McCleany BV (2003) Dietary
Nyman EMG-L (2003) Impor-
tance of processing for
physico-chemical and physi-
ological properties of dietary
187-192.
Prosky L, Asp N-G, Schweizer
TF, DeVries JM, Furda I
(1988) Determination of to-
tal dietary fiber in foods and
food products: collaborative
Chem. 71: 1017-1023.


