# Fruit and vegetable by-products and breakfast cereals products: can they meet?

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## Framework

This work aimed to review the application of fruit and vegetable by-products into breakfast cereals products based on extrusion process.

## Fruit and vegetable by-products

**They are** peels, stems/cores, leaves, pomaces, unripe or damaged fruit/vegetable.

**Correspond to** ~14% of all food produced[1] and ~50% of industrial manufacturing[2].

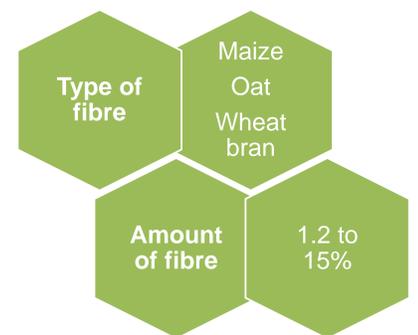**Rich in fibre:** from 30 to 90% of dry weight

**Rich in bioactive compounds** (mostly bound to the fibre): phenolic acids, flavanols, flavonols, flavanones, flavones, coumarins, anthocyanins, carotenoids, tocols.

**Health benefits:** antioxidant activity, gut microbiota improvement, satiety increase, lower energy intake, prevention of chronic diseases (diabetes, obesity, cancers, cardiovascular diseases).
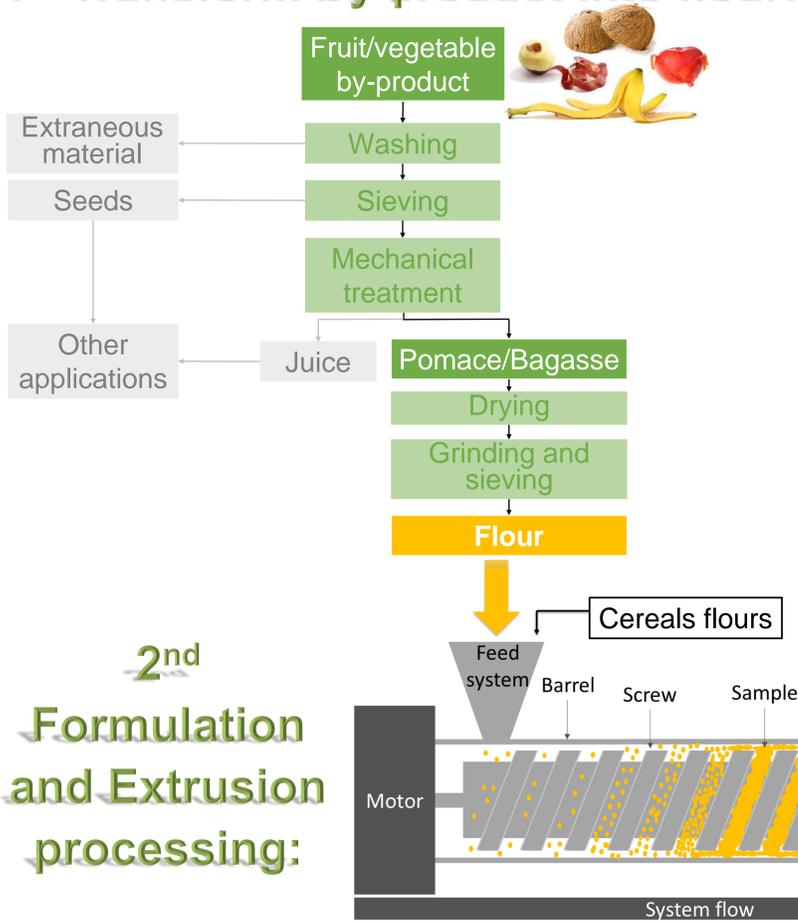
## Breakfast cereals products

**Health benefits** are related to their fibre content: reduce risk for several diseases, including obesity, and are a good source of vitamins and minerals[3].

**However**, they have both limited type and amount of fibre[4] and its consumption is associated with higher intakes of total sugar[3].

| Type of fibre | Maize Oat Wheat bran |
| Amount of fibre | 1.2 to 15% |

## How can they meet? The method, advantages and challenges

### 1st Transform by-product into flour:

Fruit/vegetable by-product → Washing → Sieving → Mechanical treatment → Pomace/Bagasse → Drying → Grinding and sieving → **Flour**

Extraneous material, Seeds, Other applications, Juice

### 2nd Formulation and Extrusion processing:

Cereals flours → Feed system → Motor, Barrel, Screw, Sample, Die → System flow → **Novel breakfast cereals product**

### Advantages

**By-product flour:**
↑ fibre content
↑ antioxidant activity and health benefits
↑ bioactive compounds content

**Extrusion processing:**
Improves dietary fibre profile (↓ insoluble and ↑ soluble dietary fibre).
↑ antioxidant activity and health benefits by releases bound phenolics from fibre.

### Challenges

**By-products flours:**
↓ texture quality (↑ hardness and bulk density, ↓ crispiness)

**Extrusion processing:**
↓ free bioactive compounds content from by-products flours

**BUT**

Processing conditions may be optimized to overcome these difficulties, namely, moisture content, screw speed and barrel temperatures

## Conclusions

To improve the bioactive compounds content and biological properties of these products, the flours' production process must be as mild as possible, in order to avoid the loss of free bioactive compounds at this stage so they can be released during extrusion instead.

Extrusion technology is a promising technique to create high fibre breakfast cereal products through incorporation of fruit and vegetable by-products flours, once several processing conditions must be controlled to improve texture quality of the product assuring at same the increasing fibre content.

## References

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