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Plant foods for the prevention and management of colon cancer

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ABSTRACT

Colon cancer is a common malignancy in the digestive system with a high prevalence in recent years. Dietary natural products have been widely investigated for the prevention and management of colon cancer. The studies showed that several plant foods have the potential to prevent and manage colon cancer, such as berries, plums, pomegranates, cruciferous vegetables, tomatoes, garlic, turmeric, ginger, soy, whole grains, and mushrooms. These plant foods usually contain fibers and phytochemicals that can restrain the development and progression of colon cancer in various ways, such as protecting against colon carcinogens, inhibiting tumor growth and metastasis, and inducing apoptosis and cell cycle arrest. This review summarizes the potential prevention and management capabilities of plant foods and their bioactive components on colon cancer by epidemiological, experimental and clinical studies, and special attention is paid to the underlying mechanisms.

1. Introduction

Cancer is the second leading cause of death worldwide following cardiovascular diseases (Kaur and Kaur, 2015). It is estimated that 1,688,780 cancer cases and 600,920 cancer deaths would occur in the United States in 2017 (Siegel, Miller, & Jemal, 2017). Colon cancer is the third most common cancer and the second leading cause of cancer-related death worldwide (Hemeryck et al., 2016). The prevalence of colon cancer varies with the geographical conditions (O'Keefe, 2016). Besides, the incidence and mortality rates of colorectal cancer show substantial variations by race and ethnicity, with the highest in non-Hispanic blacks (Siegel et al., 2017). Several risk factors of colon cancer have been identified, such as diet rich in animal fat and low in fruits and vegetables, obesity, diabetes, and smoking (Kelly, Alberts, Sacco, & Lanier, 2012; Perdue, Haverkamp, Perkins, Daley, & Provost, 2014). In addition, the high-level intake of red meat was reported to have a positive link with colon cancer risk (Oba et al., 2006; Surya et al., 2016; Takachi et al., 2011), while adequate physical activities, particularly outdoor activities, and circulating vitamin D levels might reduce the risk of colon cancer (Aleksandrova et al., 2017).

Among the risk factors, nutrition and diet are attracting increasing attention worldwide. Three decades ago, Doll and Peto pioneered in putting forward the idea that more than 90% of gastrointestinal cancers were diet-driven (Doll & Peto, 1981), which has been supported by more and more epidemiological evidence (Grosso et al., 2017; Koushik et al., 2007). For example, a meta-analysis including 93 studies supported an association between healthy dietary patterns and a decreased risk of colon cancer (Grosso et al., 2017). However, some studies did not find significant associations between dietary food and colon cancer risk. For instance, a meta-analysis involving 25 prospective cohort studies did not report a significant association between dietary fibers in fruits and colon cancer risk (RR: 0.93; 95% CI: 0.82–1.05) (Aune et al., 2011).

Some experimental studies found that many dietary natural products might play a role in the prevention of cancer (Li et al., 2016; Li et al., 2017; Zhang et al., 2016; Zheng et al., 2016; Zhou, Li, Zhou, Zheng, Li, & Li, 2016; Zhou, Zheng, et al., 2016). Furthermore, several plant foods, such as fruits, vegetables, herbal tea and mushroom, have shown inhibitory effects on colon cancer cells (Li, Li, Li, Deng, Ling, & Xu, 2013; Li, Li, Li, Deng, Ling, Wu, et al., 2013; Xu et al., 2016). That is

Abbreviations: Ang1, angiopoietin1; Bax, Bcl-2-associated X protein; Bcl-2, B-cell lymphoma 2; Bcl-xL, B-cell lymphoma-xL; CDKs, cyclin-dependent kinases; COX-2, cyclooxygenase-2; ERK, extracellular regulated protein kinase; IκBα, inhibitor of NF-κB; IL, interleukin; IGF1, insulin-like growth factor-1; Jak2, Janus kinase; JNK, c-Jun N-terminal kinase; MAPK, mitogen-activated protein kinase; MMP, matrix metalloproteinase; mTOR, mechanistic target of rapamycin; NF-κB, nuclear factor kappa-light-chain-enhancer of activated B cells; PI3K, phosphatidylinositol 3-kinase; PKB, protein kinase B; ROS, reactive oxygen species; STAT3, signal transducers and activators of transcription 3; TNF-α, tumor necrosis factor α; VEGF, vascular endothelial growth factor; XIAP, X-linked inhibitor of apoptosis protein

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Table 1
Epidemiological studies on association between plant foods intake and dietary pattern and colon cancer.

Plant foods/dietary pattern	Study type	Subject	Outcome	Association	Ref.
All food groups	Case-control study	613 cases and 996 controls African-Americans and Caucasians	Colon cancer risk	All vegetables and dark green deep yellow fruits/vegetables 30–50% lower risk of colon cancer; fruits/fruit juices a non-significant 30% risk reduction -dairy products consumption increased the risk of colon cancer (OR 1.9; 95% CI: 1.1–3.4)	Satia-Abouta et al. (2004)
Dietary fiber	Cohort study	519,978 individuals aged 25–70 years taking part in the EPIC study from ten European countries	CRC risk	RR (95% CI) for the highest versus lowest quintile of fiber from food intake: 0.58 (0.41–0.85)	Bingham et al. (2003)
Dietary fiber	Cohort study	57,774 participants in the PLCO Trial	Risk of distal colorectal adenoma	OR (highest dietary fiber intake vs. lowest intake): 0.76 (0.63–0.91)	Kunzmann et al. (2015)
Fruits and vegetables	Cohort study	442,961 participants in the EPIC study	Colon cancer risk	Combined consumption of fruit and vegetable (HR Q4 vs. Q1: 0.87, 95% CI: 0.75–1.01, *P* for trend 0.02) -no significant association between certain type of fruits or vegetables and colon cancer	Leenders et al. (2015)
Fruits and vegetables	Cohort study	61,274 male participants aged 40–74 years in Shanghai Men's Health Study	CRC risk	Fruit consumption (fifth vs. first quintile HR: 0.67; 95% CI: 0.48–0.95; *P* trend = 0.03) –no significant association between vegetables and colon cancer risk	Vogtmann et al. (2013)
Whole grain	A nested case-control study in a cohort	120,016 men and women in the HELGA cohort	CRC incidence	No significant association	Knudsen et al. (2014)
Dietary soyfood	Case-control study	901 CRC cases and 2669 controls recruited at the National Cancer Center, Korea	CRC risk	Highest intake quartiles of isoflavones compared to the lowest intake quartiles in men (OR: 0.67, 95% CI: 0.51–0.89) and women (OR: 0.65, 95% CI: 0.43–0.99)	Shin et al. (2015)
aMed	Cohort study	87,256 women and 45,490 men	CRC incidence	No significant association for aMed score	Fung et al. (2010)
DASH				RR for the highest DASH score compared to the lowest (95% CI) 0.80 (0.70–0.91)	
HEI-2010 diet	Cohort study	190,949 African American, Native Hawaiian, Japanese American, Latino, and white individuals	CRC risk	HR (95% CI) highest vs lowest quintiles: 0.69 (0.59–0.80) in men and 0.82 (0.70–0.96) in women	Park et al. (2017)
AHEI-2010 diet				HR (95% CI) highest vs lowest quintiles: 0.75 (0.65–0.85) in men and 0.90 (0.78–1.04) in women	
aMed diet				HR (95% CI) highest vs lowest quintiles: 0.84 (0.73–0.97) in men and 0.96 (0.82–1.13) in women	
DASH diet				HR (95% CI) highest vs lowest quintiles: 0.75 (0.66–0.86) in men and 0.86 (0.75–1.00) in women	
aMed and DASH	Cohort study	215,000 African-American, Native Hawaiian, Japanese-American, Latino, and white adults living in Hawaii and California	CRC risk	A higher aMED score was associated with lower CRC-specific mortality in women (HR: 0.86; 95% CI: 0.77–0.96) but not in men (HR: 1.01; 95% CI: 0.92–1.11)	Jacobs et al. (2016)
HEI-2010, AHEI-2010, aMED, and DASH	Cohort study	938 cases of CRC and 238 CRC-specific deaths	CRC incidence	HEI-2010 score (HR 0.81, 0.77, and 0.73 for quintiles 3–5 vs. quintile 1, respectively) and DASH score (HR: 0.72, 0.74, and 0.78) were negatively associated with CRC incidence	Vargas et al. (2016)
			CRC-specific mortality	No significant association between diet and CRC-specific mortality	

CRC stands for colorectal cancer.